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PROSPECT STREET, RYE — By T. K. Grant, F.R.P.S.

A photograph in natural colours, taken on the Autochrome plate, and reproduced by the four-colour process.

CASSELL'S
CYCLOPAEDIA OF PHOTOGRAPHY

EDITED BY
BERNARD E. JONES

ILLUSTRATED BY TWENTY-FOUR FULL-PAGE PLATES IN COLOUR AND HALF-TONE, AND BY HUNDREDS OF LINE DRAWINGS IN THE TEXT

VOLUME I

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PREFACE

MANY years ago, while assisting in the production of a small photographic manual, the difficulty experienced in finding room for everything that ought to have been included brought to my mind a suggestion for an encyclopædic work covering all the phases of photography. It was not until this suggestion had been discussed, seven years later, with Mr. Percy R. Salmon that it became crystallised into something concrete and workable. To Mr. Salmon, more than anyone else, is due the credit for the particular form which this work has assumed. Together we planned it, and together decided the majority of the multitudinous questions of detail that arose.

Of photographic dictionaries and cyclopædias printed in the English language there have been as many as could be counted on the fingers of one's hands; but the present volume is essentially different from any of them, and is undoubtedly the most ambitious work of its kind yet projected. With possible exceptions, its predecessors were written or compiled from cover to cover by one hand; whereas this work is the result of the co-operation of many men, each having special knowledge of his own particular branch. Modern photography has so many ramifications, each calling for the application of special knowledge, that I felt that the only proper course, in attempting to produce a photographic cyclopædia at once authoritative and complete, was to enlist the services of as many specialists as possible. About a score of the best-known and most authoritative expert photographic writers extended their co-operation, and their contributions constitute the bulk of this work.

While it must be confessed that complete accuracy is almost too much to hope for in the first edition of a work of reference, I have taken care to do all that could be done to check and verify the statements made. My especial thanks in this connection are due to Messrs. Percy R. Salmon, E. J. Wall, Arthur Lockett and William Gamble, for the trouble they have taken in reading the proofs. I shall appreciate and acknowledge any minor corrections that readers may send me, and shall hope to be able to incorporate them in later editions, in the happy event of such being called for.

The scope of the work demands some words of explanation. The object has been to include every accepted photographic term and to survey the whole field of photographic knowledge, whilst giving particular attention to the requirements of the working photographer, both amateur and professional. This cyclopædia is intended essentially as a simple guide to photographic practice, whatever else it may be. In all cases where the process described is commonly used, or is likely to be worked nowadays, working directions and definite formulæ are given.

This work is intended not only for the practical photographer, but also for the scientific student, who will find in all those articles that have been written especially for him valuable, because authoritative, summaries of what has already been attained in the many branches of photographic science. The manufacturer, too, especially the manufacturer of materials, will find in this volume a mass of information relating to what others have done before him, and by profiting by it he will be prevented from wasting time and money in useless trials in some directions and possibly be given ideas as to commercially remunerative lines of experiment in others.

There are two matters, in particular, upon which I think it desirable to address a word to the critical reader. It will be noticed that a few biographies are given, and the question as to why such and such men are included and others omitted is sure to arise. The biography of no living photographer will be found in these pages; and with regard to the dead worthies, I have done my best to include only those who, when viewed historically, have real claims to distinction. And in such a matter much must be left to personal opinion. The other matter is the omission, with a few exceptions, of trade names. Their inclusion, a highly debatable point, would have meant the addition of more than thirteen hundred headings, the information given under which might rapidly have gone out of date. The exceptions, as in the case of a certain camera which it would be superfluous to mention, have now become part of the language, and are associated in the public mind quite as much with broad types of apparatus or certain classes of materials as with any particular brands of manufacture.

The illustrations call for a word of explanation. The monochrome plates have been selected as representing separate phases of photographic art, and are offered as being good examples of their kind. On the other hand, three of the coloured plates are intended to represent merely the capabilities of the screen plates with which the original pictures were made; while, of the remaining two, one plate shows the steps in the production of a four-colour print and the other the composition of six of the best-known screen plates. The line drawings throughout the book (almost all of which have been drawn by E. S. W. Cunnington from the contributors' sketches) have the sole object of elucidating the text; much thought was given to the advisability or otherwise of using photographic illustrations in the text, but it was decided that drawings would be far more instructive. In many cases the drawings have been based upon illustrations appearing in trade catalogues, and in this connection my thanks are due to a large number of firms, including the following: Adams & Co.; A. H. Baird; Bausch and Lomb Optical Co.; R. and J. Beck, Ltd.; W. Butcher and Sons, Ltd.; J. J. Griffin and Sons, Ltd.; J. Fallowfield; J. Halden and Co.; Houghtons, Ltd.; Infallible Exposure Meter Co.; Kodak, Ltd.; J. Lancaster and Son, Ltd.; Marion and Co., Ltd.; G. Mason and Son; Newman and Guardia, Ltd.; A. W. Penrose and Co., Ltd.; Ross Ltd.; Sanger Shepherd and Co., Ltd.; O. Sichel and Co.; Thornton-Pickard Mfg. Co., Ltd.; W. Tyler; A. G. Voigtländer and Sohn; Watkins Meter Co.; W. Watson and Sons, Ltd.; Westminster Engineering Co., Ltd.; Westminster Photographic Exchange, Ltd.; and C. Zimmermann and Co.

For the principal information given in the article "Ceramic Process" I am indebted to Mr. W. Ethelbert Henry's standard work, "Photo-Ceramics."

With regard to the formulæ, in practically all cases the parts are given in both British and Metric measures; by whichever system a solution is made up, the relative proportions of the ingredients will be almost exactly the same, although the actual quantities nearly always differ.

B. E. J.

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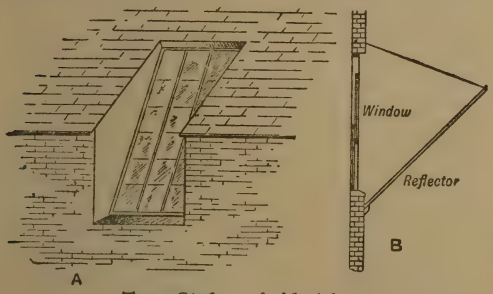
CASSELL'S

Cyclopædia of Photography

ABAT-JOUR (Fr.) (Ger., *Schräge Fenster, Oberlicht*)

A skylight or aperture for admitting light to a studio, or an arrangement for securing the same end by reflection. In the days when studios for portraiture were generally found at the tops of buildings not originally erected for that purpose, and perhaps in narrow thoroughfares or with a high obstruction adjacent, it became necessary to obtain all the available top light. This alone, however, is not well suited for artistic lighting, a side light being usually preferable. The abat-jour, therefore, was so designed as to give what was practically a side light, although coming principally from above. A style much used formerly, and still occasionally met with, is



Two Styles of Abat-jour

shown at A. Into a bevelled opening cut in the wall, the roof, or both, is let a slanting glazed frame. Another form (B) is an inclined box-like structure open at the top and furnished with a mirror, or painted white inside, to reflect light downward through the window or glazing. The reflector used in daylight enlarging is really an application of the latter kind of abat-jour, by which the light, falling vertically from the sky, is reflected in a horizontal direction on the negative in the enlarging camera.

ABAXIAL

Away from the axis. A term applied to the oblique or marginal rays passing through a lens.

ABBE CONDENSER

One of the most popular types of substage condensers for the microscope and used in photomicrographic work. It is made in two forms. The first consists of two lenses, and is of low numerical aperture. The second, used for high-power objectives, has three lenses, and is of higher numerical aperture (N.A.).

ABBE, ERNST

Professor Abbe died at Jena on January 14, 1905, aged 65 years. He was associated with the optical firm of Carl Zeiss, and paid particular attention to microscope objectives, with which his name is now generally connected. In 1881 he took an interest in the smelting of new optical glasses which was being made by Dr. Schott, and this was the beginning of the Jena glass factory of Schott and Genossen, the products of which have been used by lens makers as the raw materials of the large-apertured lenses known as anastigmats. Professor Abbe was the first to apply these glasses in a practical way to photographic lenses. On the death of Carl Zeiss in 1888 Professor Abbe became sole proprietor, and in 1896 he introduced an arrangement by which the employees became practically the owners of the business.

ABERRATION (Fr., *Aberration;* Ger., *Abirrung*)

A term used in photographic optics to express a fault in a lens. (*See* "Chromatic Aberration," "Spherical Aberration," "Curvilinear Distortion," "Astigmatism," etc.)

ABRADING POWDER

Rubbed on the smooth surface of dried negatives and bromide enlargements in order to give a "tooth" for subsequent pencilling. Such abrasives as pumice, cuttle-fish bone, etc., are generally used, and these must be very finely ground and be free from grit. On negatives the powder is rubbed on lightly with the finger-tip, but on bromide prints it is applied with a leather stump. An excellent abrading powder for negatives consists of 1 part of powdered resin and 2 parts of cuttle-fish bone, the whole being sifted through silk. Cigar or tobacco ash also serves the purpose. Negatives may be reduced by means of a moist abrading mixture as described under the heading "Baskett's Reducer." Various grades of emery powder and carborundum are used in lens and screen grinding, etc.

In process work, pumice and emery powders are used with water for cleaning or polishing zinc or copper. Fine emery powder is employed for graining the thick glass plates used for collotype printing. Pumice powder is used for removing gloss from prints that have to be retouched.

ABRASION MARKS

Black or pencil-like markings upon bromide and gaslight papers, chiefly occurring on glossy surfaces. They are seen only upon the finished print, and are due to pressure upon the gelatine film, and particularly to scratching against the printing frame or edges or corners of the packet when withdrawing the sheets. Handling the paper carefully will prevent them, and the use of a special developer, such as the following, will generally be of assistance :—

Metol . . .	34 grs.	3·4 g.
Hydroquinone .	60 ,,	6 ,,
Sodium sulphite .	240 ,,	24 ,,
Sodium carbonate	400 ,,	40 ,,
Potass. iodide .	20 ,,	2 ,,
Potass. bromide (10 %)	36 drops	4 drops.
Water to . . .	20 oz.	1,000 ccs.

Any other metol-hydroquinone developer may be used if 1 grain of potassium iodide is added to each ounce of developer used. The addition of potassium cyanide is also resorted to, the proportion being 3 or 4 drops of a 10 per cent. solution to 1 oz. of developer. But the use of a special developer does not answer for all papers. Abrasion marks may often be removed from the finished print by rubbing lightly with a pad of cotton wool soaked in water, weak ammonia (5 drops per ounce of water), or methylated spirit. An effective—although rather troublesome—plan is to immerse the finished print for one minute in the following solution :—

Potass. iodide .	20 grs.	2 g.
Iodine . . .	2 ,,	0·2 ,,
Water . . .	20 oz.	1,000 ccs.

When the white parts of the print turn blue, transfer to a fresh "hypo" fixing bath for five minutes, and then wash thoroughly. If the iodide bath is allowed to act too long, it acts as a reducer.

ABSORPTION (Fr., *Absorption;* Ger., *Absorption*)

This term is used both in a chemical and an optical sense. In the former sense it is used to designate the taking up of one substance by another, just as a sponge absorbs or sucks up water. As a rule, this is not accompanied by any chemical, but merely a physical change.

Optically, absorption is applied to the suppression of light, and to it are due all colour effects (*see* "Colour"). It is of great importance from a photographic point of view, as on Draper's law, according to which only those rays which are absorbed by a substance act chemically on it, is based the whole of the photochemical action of light. Light, when absorbed, is not lost but is converted into some other form of energy, either heat or chemical action. The absorption spectra of dyes are of great interest, as by their aid it is possible to prepare colour filters of any given tint. Many substances and dyes have simple absorption spectra—that is to say, more or less well defined continuous portions of the spectrum are absorbed; other substances, on the other hand, such as chlorophyll, have complicated absorption spectra, which change in character according to the concentration of the solution, or the depth of the solution, which is practically the same thing.

The position and shape of the absorption bands of a substance are in many cases so characteristic that they serve as a means of identification. Obviously, the most opaque substances are the metals, but even these are translucent in thin films; silver, for instance, appears blue, whilst gold in thin films is green. Even such transparent and colourless substances as water, alcohol, glycerine, etc., possess characteristic absorption spectra, and therefore appear coloured when in sufficiently thick films. In studying the absorption spectra of coloured solutions, either the visual or the photographic method may be used, and the latter will be found not only more reliable, but considerably quicker. The visual method can obviously be applied only to the visible portion of the spectrum, whilst by the aid of photography the ultra-violet and infra-red regions can also be mapped out.

Dr. Kenneth Mees and S. H. Wratten, who have made a special study of dye absorption spectra by photographic means, give the following outline of the methods which may be adopted : "(1) One may take a series of photographs with increasing dilution of the dye; (2) one may take a series of photographs with a constant concentration of the dye, but an increasing thickness of the cell; (3) one may take a series of photographs with a constant concentration and constant cell thickness, but with a varying exposure. These three methods will all produce results differing slightly, though (1) and (2) are nearly equivalent to one another. (1) is a very slow method, and it would be probably quicker to use a spectro-photometer. (2) and (3), though quicker, are still slow if carried out as described. But if in method (2) instead of varying thicknesses of cell there is used a cell of which the thickness varies throughout the length—that is to say, a wedge-shaped cell placed in front of the slit so that the thickness of the layer of dye solution in front of the slit varies from end to end of the slit—the method resolves itself into taking one or possibly two photographs of each dye. Method (3) is inferior to the two other methods, as it involves the interpretation of the photograph of the plate curve. It is, however, a convenient way of examining the absorptions of coloured films and filters." This method is most conveniently carried out by placing directly in front of the slit a small wedge of black glass so that the intensity of the light varies from end to end of the slit. This black wedge consists of a narrow prism of neutral tinted glass cemented to a similar prism of white glass, which of course destroys the prismatic effect by forming a parallel plate. With this the intensity of the light varies from 1 to 10,000.

For visual measurement of absorption spectra a spectro-photometer is used. This consists of a spectroscope and some means of comparing the brightness of two spectra of one light source. This can be effected in several ways, as, for

instance, by two slits, which can be independently opened or closed, or by polarising prisms. The disadvantage of the variable slit system is that the two spectra are of unequal purity, and therefore accurate readings are impossible. In the polarising spectro-photometers the slit is usually divided across the middle by a small bar of metal, and the two light beams are polarised and dispersed, or dispersed and polarised, equality being obtained by rotation of a Nicol prism. The two spectra are brought into juxtaposition at the eyepiece, and equality of illumination obtained throughout its length. As one spectrum is continuous and the other darkened by the absorption band, the former is reduced in brightness till the two are equal and the necessary readings obtained from the varied width of the slit or the angle through which the Nicols are turned. The transmitted light, divided by the incident light, which is always taken as unity, equals the extinction coefficient.

ACCELERATOR (Fr., *Accélérateur;* Ger., *Beschleuniger*)

A substance added to developing solutions to shorten the duration of development and bring out the image more quickly. Usually it is an alkali which hastens the development owing to its power of absorbing the bromine set free from the silver salt during development, thus forming an alkaline bromide which acts as a restrainer, and as this increases with continued or repeated use of a developer, due allowance should be made.

Common accelerators are sodium carbonate, washing soda, ammonia, potassium carbonate, sodium hydrate (caustic soda), and potassium hydrate (caustic potash). "Hypo" (sodium hyposulphite) has been recommended when developing with a mixture of ferrous-oxalate, but not infrequently it causes a partial reversal of the image; merely adding a few drops of a weak solution of "hypo" to the normal developer has a wonderful accelerating effect in some cases. Attempts have been made to introduce substitutes for alkaline accelerators in the form of acetone with sodium sulphite, tribasic sodium phosphate, and other chemicals, but only the two named have met with any success. Some "one solution" developers—such as rodinal, azol, etc.—include an accelerator; but in "two solution" developers, the developer proper is generally included in bottle "A" or "No. 1," and the accelerator in bottle "B" or "No. 2." It was long thought that an increase of the accelerator in cases of under-exposure brought out more detail, but photographers are now growing out of the idea. It is never advisable to add much alkali, because this invariably tends to produce fog. Accelerators cannot be used as the fancy dictates, some being more suitable for certain developers than others. Ammonia and sodium carbonate, for example, are found to give their best results in conjunction with pyro. Some of the newer developers—amidol, for example—do not require an alkali accelerator, and they will work with sodium sulphite, which is a preservative rather than an accelerator. In regard to the comparative strengths of the numerous alkalis used for accelerating development, a table will be found under the heading "Alkalis, Chemical Equivalence of."

ACCOMMODATION OF THE EYE (*See* "Axial Accommodation.")

ACCUMULATOR (Fr. *Accumulateur;* Ger., *Akkumulator*)

Accumulators or storage batteries are used in X-ray work when the electric current cannot be obtained from mains. An accumulator consists of a series of lead grids filled in with lead oxide and immersed in dilute sulphuric acid. The potential of an accumulator when fully charged is 2 volts, and recharging is necessary when it falls to 1·8. Current is always leaking from accumulators even when not in use, and they should therefore be recharged at least once a month, or the plates will be ruined. The positive terminal of a cell is painted red, the negative black. In coupling up two or more cells the positive terminals are connected up with the negative terminals, the free terminals being then connected with the induction coil. A coil giving a 10-in. spark requires from six to eight accumulators, supplying a current of 5 to 10 amperes.

ACETALDEHYDE (*See* "Aldehyde.")

ACETATES

Salts formed by acting upon metals or their oxides with acetic acid. Examples are lead acetate, sodium acetate, etc., etc., which are described under their own headings.

ACETIC ACID (Fr., *Acide acetique;* Ger., *Essigsäure*)

Also known as purified pyroligneous acid. $HC_2H_3O_2$. Molecular weight, 60. There are three kinds of acetic acid:—(1) glacial, containing about 99 per cent. of acid and 1 per cent. of water (sp.g., 1·065); glacial acetic acid is the most widely used for photographic purposes, and receives its name from the fact that it solidifies and freezes into long ice-like crystals at comparatively low temperatures; (2) commercial "strong," about one-third the strength of the glacial variety, and containing about 33 per cent. of acid, sometimes known as Beaufoy's acetic acid (sp.g., 1·044); (3) dilute acetic acid, made by mixing 1 part of the "strong" acid with 7 parts of water (4⅛ per cent.), and sold as "distilled white vinegar" (sp.g., 1·006). Acetic is the oldest of acids, and is given in old dictionaries as "acetous acid." Its impurities may be hydrochloric, sulphuric and sulphurous acids, but most samples sold by chemists are quite pure enough for photographic purposes. Acetic acid readily dissolves in water, alcohol, and ether; it is a strong escharotic, causing painful blisters if allowed to remain on the skin, but the application of a solution of soda or any other alkali will at once neutralise it. It is extremely volatile, and should be kept in a glass-stoppered bottle and in a cool place. It has many uses in photography, and in the early days, when it cost as much as 8d. per ounce, was largely used as a constituent of the developer for wet plates. Nowadays, it is used for clearing the iron out of bromide prints after development with ferrous oxalate, to assist uranium toning, and, on rare occasions, as a restrainer when developing with hydroquinone. Acetic acid is a solvent for celluloid, gelatine, and pyroxyline.

In process work, acetic acid is used in the iron developer for wet plates. The amount required increases as the working temperature increases; at 60° F. ½ oz. of glacial acetic acid to 20 oz. of developer is a suitable proportion. The acid retards the action of the ferrous sulphate. A mixture of acetic acid and salt is used for cleaning up the copper plates during half-tone etching to enable the etcher to see the image better when proceeding to re-etch. It is also used for removing the magnesia that is rubbed into the etched plate to make the image visible.

ACETIC ETHER (Fr., *Éther acétique, Acétate d'éthyle ;* Ger., *Essigaether*)

Synonym, ethyl acetate. CH_3 CO $O(C_2H_5)$. Molecular weight, 89. Solubilities, 1 in 17 water, miscible in all proportions with alcohol and ether. It should be kept in well-stoppered bottles away from fire, as the vapour is very inflammable. A light, volatile, colourless liquid, with pleasant acetous smell, obtained by distillation from alcohol, acetic acid, or sodium acetate with strong sulphuric acid. Sometimes used in making collodion.

ACETOL (Fr., *Acétol;* Ger., *Acetol*)

A gelatine with an acetic acid substratum, used for collodion emulsion. It is said by its advocates to give a beautiful surface and spotless negatives.

ACETOMETER (Fr., *Acétomètre ;* Ger., *Acetometer*)

A hydrometer specially graduated to show the strength of acetic acid.

ACETONE (Fr., *Acétone ;* Ger., *Aceton*)

A colourless volatile liquid of peculiar and characteristic odour, having the formula $C_3 H_6 O$ or CH_3 CO CH_3. It is met with commercially in various qualities. It is miscible in all proportions with water, alcohol, and ether. As the vapour is highly inflammable, the liquid should be kept in a bottle with a close-fitting cork or glass stopper. Acetone has two separate and distinct uses in photography, as an addition to developers and in varnish making. It acts as a solvent for resins, camphor, celluloid, etc., and should therefore never be used for films or in a celluloid dish.

As a constituent of a developer acetone works best perhaps with pyro in the following one-solution form :—

Pyro	180 grs.	18 g.
Sodium sulphite (crystals)	1,120 ,,	112 ,,
Acetone	24 mins.	2·4 ccs.
Water to	20 oz.	1,000 ,,

It may, however, be used with other developers. When mixed with sulphite it forms acetone sulphite, and the soda of the sulphite combines with the developing agent to form a phenolate, so that it may be used in place of an alkali when sulphite is present. It gives a very clean-working developer, moderately free from stain, and hardens the gelatine, or at any rate does not soften it as alkalies do. As a developer for paper prints it is best when combined with metol-hydroquinone in the following form :—

Metol	27 grs.	2·7 g.
Sodium sulphite	½ oz.	275 ,,
Hydroquinone	88 grs.	8·8 ,,
Potass. bromide (10 %)	22 mins.	2·2 ,,
Acetone	40 drms.	25 ccs.
Water to	20 oz.	1,000 ,,

This is a one-solution developer which, as above compounded, is ready for use for both plates and papers.

ACETONE SULPHITE (Fr., *Acétone sulfite ;* Ger., *Acetonsulphit*)

A compound of acetone with acid sodium sulphite, introduced as a substitute for sodium sulphite and the metabisulphites for development. It has the form of a white powder, and its formula is $NaHSO_3$ $CO(CH_3)_2$ H_2O. It is soluble in water (up to 50 per cent.), but less so in alcohol, and it is used for making concentrated forms of developers, also for fixing baths and to blacken negatives after being bleached with mercury. Unlike acetone itself, it does not make the developer active, and consequently an alkali or a carbonate must be used. Ten parts of acetone sulphite are equivalent to 7 parts of potassium metabisulphite or 20 parts of anhydrous sulphite of soda (40 of soda sulphite crystals) in a developer. As a preservative for pyro, ½ oz. of acetone sulphite should be added for each ounce of dry pyro used.

ACETOUS ACID

The old, and now obsolete, name for acetic acid (*which see*).

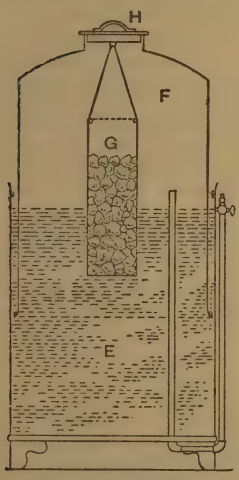
ACETYLENE (Fr., *Acétylène;* Ger., *Acetylen*)

A hydrocarbon gas (C_2H_2) having, when pure, a sweet odour, the well known unpleasant smell associated with this gas being due to the presence of impurities. It burns in air with a very bright flame, and is largely used by photographers for studio lighting, copying, etc., and as an illuminant in enlarging and projection lanterns. It is produced by the action of water upon calcium carbide (*which see*), 1 lb. of which will yield about 5 ft. of gas. It was first described and demonstrated in the year 1836 at a meeting of the Royal Dublin Society under the auspices of Edmund Davy, a professor of chemistry, and was brought into commercial use about half a century later by the discovery of the modern method of manufacturing calcium carbide in the electric furnace. Acetylene forms, like other combustible gases, an explosive mixture with ordinary air, the presence of as little as 4 per cent. of the gas being sufficient to constitute a dangerous combination. It was in the early part of 1895 that photographers began to turn their attention to the photographic value of acetylene, and photometric tests prove that acetylene has eight times the actinic power of the average incandescent gas mantle. As an illuminant in optical lanterns, acetylene is better than the incandescent gas mantle, but not so good as limelight. (*See* "Optical Lantern Illuminants.")

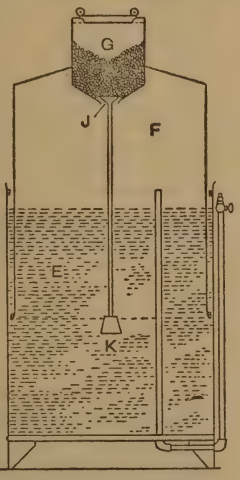
ACETYLENE GENERATOR (Fr., *Générateur d'acétylène ;* Ger., *Acetylengasentwickler*)

An apparatus for generating acetylene by the action of water on calcium carbide. Of the two

types of generators, that is probably the better in which the carbide is immersed in or dropped into the water, as when water is permitted to fall on the carbide great heat is created, tending to the production of inferior gas, and the evolution of oily products which are liable to accumulate in the pipes. However, many generators in which the water drips very slowly on the



A. Bucket-type Acetylene Generator



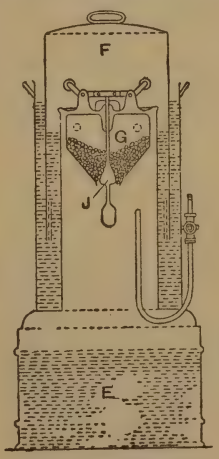
B. Hopper and Valve-type Acetylene Generator

carbide, as in the majority of acetylene lamps for cycle use, have a high reputation. Carbide to water generators are illustrated herewith. In the apparatus shown at A the water is contained in the tank E, in which slides the gas bell or reservoir F. The receptacle G, filled with lump carbide, is suspended from the top of the reservoir, which falls by its own weight, acetylene beginning to generate directly the carbide comes in contact with the water. The gas, filling the reservoir, causes it to rise and lifts the carbide receptacle, thus stopping further generation until by the consumption of the gas the reservoir again falls. The carbide receptacle is introduced or removed by extracting the tightly-fitting plug H. In the generator shown at B granulated carbide is contained in the hopper G, in which is a small opening or valve closed by the conical plug J. The plug is attached to a rod having a weight K as its lower end. The reservoir falls when empty, until the weight strikes the bottom of the water tank, this causing the rod to push up the plug J, allowing a small quantity of carbide to fall through the opening. The ascent of the reservoir as gas is generated raises the weight, which pulls down the plug and again closes the aperture. B is better in principle than A, as the carbide is acted upon in smaller quantities at a time.

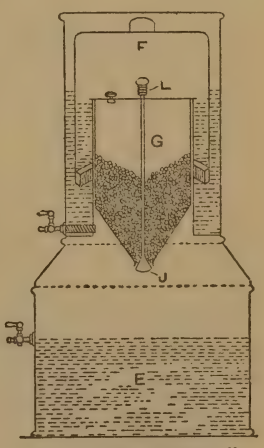
In all the earlier generators the carbide receptacle was attached to the reservoir, causing an unnecessary pressure, and one also that varied as the carbide was consumed. Another disadvantage was the fact that the waterseal was furnished from the same water as that used for generation. In the devices shown at C and D these objections are obviated. In the former of these the plug J is weighted to keep it normally closed, and its rod is connected at its upper end to a T-piece, this being in turn pivoted at each side to angle irons, which carry wheels at their outer ends. The reservoir F, in falling, depresses the angle irons, and these raise the plug rod by means of the T-piece, thus liberating a small charge of carbide. The plug is re-closed by the weight as the gas-laden reservoir rises. In the device shown at D the hopper G containing the carbide has an upward-closing plug J fixed to a rod. The reservoir F in falling presses on the top of the rod and opens the plug, while the spring L serves to return the rod and close the opening when the reservoir rises.

Except when the carbide is dropped in small quantities into a sufficient excess of water, a washing apparatus of some kind is called for. If any quantity of acetylene is made, it is better also to remove the remaining impurities by passing the gas through calcium chloride with which is mixed a little unslaked lime, the mixture being contained in muslin bags arranged on perforated shelves, one over the other, in the purifier. A similar mixture is sold ready-prepared, and with this no bags or shelves are required, the lumps being merely packed in the receptacle.

The pressure should not rise above two or three inches of water in the generator, and the pipes should not be less than $\frac{3}{8}$ in. diameter. All taps must be well ground in, and should be lubricated with vaseline to prevent the corrosive action exerted by acetylene on brasswork. Since the gas leaks more easily than ordinary house gas, greater care must be taken with all joints. Tar and paint are quickly affected,



C. "Ever Ready" Acetylene Generator



D. "Dreadnought" Acetylene Generator

and should not be used for this purpose; red-lead or white-lead, applied sparingly, is best. To detect a leak, a solution of soap and water may be applied, noticing if bubbles appear. In starting, the first gas coming off should be allowed to escape, as it contains an admixture of air. The generator should be kept at least 8 ft. or 10 ft. distant from any light, and no light should be at hand when emptying it after use. Copper should not be employed in acetylene

generators, as under certain conditions a detonating explosive compound is formed. The best material for the body is tinned or galvanised sheet-iron, brass being used only for taps.

Special burners are required for acetylene. The best are of steatite, on the air-injector principle. For photographic use, Bray's ooooo (acetylene) burners are perhaps most suitable. Fifteen of these, mounted in a white reflector, can be employed for studio portraiture, but a slightly larger number is better. Two-, three-, and four-burner jets are made for optical lantern and enlarging purposes. The soot that soon collects on the burners may be removed with a toothbrush or anything similar, while the holes may be cleared with a fine needle or wire.

ACETYLIDE EMULSION

Wratten and Mees prepared a silver acetylide emulsion by passing acetylene into ammoniacal solution of silver nitrate and emulsifying the precipitate, which is very explosive, in gelatine. They found that it blackened in daylight about ten times faster than silver chloride paper, but could obtain no evidence of the formation of a latent image with short exposures.

ACHROMATIC (Fr., *Achromatique;* Ger., *Achromatisch*)

A photographic lens is said to be achromatic when the visual image as focused upon the ground glass falls upon the same plane as the actinic image which forms the impression upon the sensitive surface. In telescopes and microscopes, achromatism means that the visual images are free from colour fringes, but it is quite possible for a photographic lens to show these fringes upon the focusing screen and yet to be capable of giving a sharply defined image upon the plate. "Actinic" is a better term to use in connection with photographic instruments than achromatic. (*See also* "Chromatic Aberration.")

ACHROMATISM

The condition of being achromatic.

ACID BLAST

The name given to an etching machine for process work, invented by Louis E. Levy, of Philadelphia. The working principle is that the acid is blown up to the plate, by means of air under compression, from a series of atomisers or sprays projecting upwards; a partial vacuum is maintained in the etching chamber above them, and the plate is held face downwards, and slowly moved to and fro horizontally to equalise the etching.

ACID CHROMATE OF POTASH (*See* "Potassium Chromate.")

ACID DEVELOPERS

A term usually applied to ferrous sulphate and other wet-plate developers in an acid condition.

ACID FIXING BATH

The "hypo" (hyposulphite of soda) fixing bath made acid. Ordinary "hypo" fixing baths are neutral, not acid; but acid fixing baths may be used for negatives and bromide and gaslight prints, although not for prints on print-out papers. Their advantages are that they immediately stop the action of the developer, prevent stains, and keep quite clear in use. It does not do simply to add any acid—say sulphuric or hydrochloric—to an ordinary "hypo" bath, inasmuch as this causes a yellow precipitation with the accompanying evolution of sulphuretted hydrogen, which militates against the permanency of the prints. Sulphurous acid, however, may be added to an ordinary hypo fixing bath in the proportion of 2 drms. to 1 pint. The best acid fixer is made by adding a little potassium metabisulphite to the ordinary solution of "hypo"; the exact proportions are of no importance, ½ oz. to 1 pint being, however, a good average. The following is a precise formula suitable for prints:—

Sodium hyposulphite .	3 oz.	150 g.
Potass. metabisulphite.	½ ,,	25 ,,
Water . . .	20 ,,	1,000 ccs.

This is suitable for negatives if the "hypo" is increased to 4 oz. A cheaper form of acid fixer is the following:—

"Hypo" solution (1 in 5)	25 oz.	1,000 ccs.

To which add a mixture of:—

Tartaric acid solution (1 in 2) . . .	¾ oz.	30 ccs.
Sodium sulphite solution (1 in 4) . .	1¾ ,,	70 ,,

There is a danger of overworking acid baths and consequently of not fixing properly, as the clearness of the solution is apt to lead to the belief that it is still in a good working condition, although really it may be partly exhausted.

ACID OXALATE OF POTASH (*See* "Potassium Oxalate.")

ACID RESIST

A term applied in process work to all substances used to form the image or protecting coating which prevents portions of the metal from being attacked. Practically all resinous bodies—bitumen, pitch, waxes, lacs, indiarubber, guttapercha—and fatty bodies form acid resists. Talc, graphite, silica, sulphur, carbon, and other inert bodies also form acid resists when dusted on to an image of a tacky nature. Non-corrosive metals form another class of resists, as the image may be formed by a metal that is not attacked by the acid, which, however, attacks the base plate. Colloid bodies—such as gelatine, glue, gums, and albumen—also form acid resists, as in the so-called "enamel process" (*which see*). Acid resists are applied as varnishes for protecting the back and margins of the plate, as etching grounds, for scratching or engraving through with needle points and gravers, as etching inks, paints, dusting powders, light-sensitive films, electrolytic deposits, fused metals. They are used for relief and intaglio etching, for lithography on stone, zinc, and aluminium, for protecting vessels and other articles used for etching, and for electrolytic etching or deposition.

ACID RESIST VARNISH

Shellac is probably the best and most used of the gum resins as a resist varnish. Cover

the shellac with wood alcohol, and leave for a few hours to dissolve. For 4 oz. of shellac about 8 oz. of methylated spirit will be required, and, for colouring, about 2 drms. of methyl violet dye. To prevent the varnish setting too hard, add to every pint about ½ oz. of linseed oil.

Shellac varnish is said to contain impurities which, when exposed to light, become insoluble, so that the varnish is difficult to remove; the remedy is to add 60 drops of oil of lavender to each pint of varnish, and use the varnish a little thinner.

ACID STAIN REMOVERS

Acid solutions used for clearing away stains caused by developers. Their use is open to objection, as fully explained under the heading "Stain Removers."

ACID SULPHITE (*See* "Sodium Bisulphite.")

ACIDS (Fr., *Acides;* Ger., *Säuren*)

Hydrogen compounds, which have a sharp taste and redden blue litmus paper. Acids may be solid, liquid, or gaseous, and are divided into strong and weak, organic and inorganic. Organic acids are usually such as contain carbon, whilst inorganic are those containing a metal. A further subdivision is made as to hydrogen or oxy-hydrogen acids; of the former, hydrochloric acid HCl is an example, and of the latter, sulphuric acid H_2SO^4, as this contains oxygen as well as hydrogen. Acids are further differentiated into mono-, di-, tri-, etc., basic acids, and this refers to the number of molecules of hydrogen which are replaceable by a metal. For instance, nitric acid HNO_3 is monobasic, and forms salts of the typical formula XNO_3 (X here being a metal). Dibasic acids can be exemplified by oxalic acid, $H_2C_2O_4$, which would form a salt having the composition of $X_2C_2O_4$—*e.g.* $K_2C_2O_4$, oxalate of potash. An example of a tribasic acid is boric acid H_3BO_3, which forms borates X_3BO_3.

In process work, acids play an important part. Nitric acid is almost exclusively the mordant used for etching zinc. Acetic, chromic, citric, fluoric, formic, gallic, hydrochloric, nitrous, phosphoric, picric, and tannic acids are all used in photo-mechanical processes.

ACIDS, TESTS FOR

Whilst strictly belonging to the domain of chemistry, it may be useful to give the usual tests for the acidity or otherwise of a solution. Blue litmus paper is reddened by acids. Phenolphthalein solution (30 grs. in 10 oz. alcohol), a colourless solution, is reddened by alkalis, and the colour discharged by acids. Methyl orange (4 grs. in 10 oz. of water), an orange solution, turns pink with acids.

ACLASTIC (Fr., *Aclastique;* Ger., *Aclastisch*)

Not capable of refracting, or bending, light.

ACRIDINE YELLOW AND ACRIDINE ORANGE NO (Fr., *Jaune d'acridine, Orangé d'acridine NO;* Ger., *Akridingelb, Akridinorange NO*)

Two complex basic aniline dyes which have been suggested as sensitisers for emulsion work. They are two of the most powerful sensitisers for green, but have found no practical application, as they stain gelatine very deeply, alcohol alone removing the stain.

ACROGRAPH (Fr., *Acrographe;* Ger., *Akrograph*)

An engraving machine invented by N. S. Amstutz, an American engineer. Its essential features are a revolving cylinder and an engraving tool—a V-shaped graver—carried along parallel to its axis; a phonograph, or a screw-cutting lathe, gives the idea. A photographic gelatine relief, such as a carbon transfer on celluloid with the image in perceptible relief, is wrapped round the cylinder, and over this relief is stretched a sheet of thin celluloid. As the cylinder revolves, a spiral thread is cut on the celluloid, this having the effect of making cuts in straight lines across the picture, but as the tool passes over the relief it cuts more or less deeply, according to the light and shade of the picture. Thus it reproduces the photograph as a kind of half-tone. The celluloid cutting can be printed from direct, or it can be made to serve as a matrix for electrotyping and stereotyping. By filling in the lines with transfer ink it can be used as a lithographic transfer, or by filling them with any opaque substance it can be used as a negative for printing an image on to metal. The elaborations from the simple principle outlined above are in the form of micrometer adjustments for the tool, a microscope and electric lamp for watching the progress of the cutting and for setting the tool, and dividing wheels for varying the pitch of the lines.

ACROMETER (Fr., *Oléomètre;* Ger., *Oelwage*)

A kind of hydrometer specially graduated for testing the specific gravity of oils; known also as an oleometer or oil tester. An instrument of this description is sometimes useful for verifying the purity of the oils used in certain photographic and photo-mechanical processes.

ACTINIC (Fr., *Actinique;* Ger., *Aktinisch*)

A term applied to light that is rich in actinism, this being the property of light that causes chemicals to combine and decompose. In the early days of photography it was assumed that only the ultra-violet, violet, and blue rays were chemically active or actinic, hence these regions of the spectrum were so termed. Later researches have proved that it is practically merely a question of length of exposure which determines the photo-chemical action of light; in other words, that all the rays of the spectrum or all colours will act on sensitive emulsions if sufficient exposure be given. The expression most usual now is the "more refrangible" or "less refrangible" rays.

In process work, where the electric arc light is almost entirely used, the actinic value of the light is of great importance. It is found that the enclosed arc is very rich in actinic rays, and these are increased by operating the lamps with a comparatively high voltage, resulting in a long flowing arc emitting a violet light. This is photographically very active, and exposures are greatly reduced compared with those necessary with the open arc.

ACTINIC DOUBLET (*See* "Lens.")

ACTINIC FOCUS

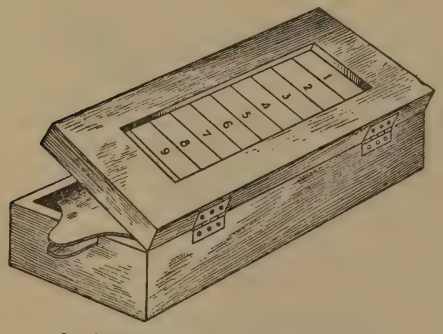
A term generally used to express the focus for the blue end of the spectrum, to which the sensitiveness of the earlier photographic plates was almost entirely limited. The focus of the yellow or strongly luminous region of the spectrum did not always coincide with that of the blue and violet rays, so that an image sharply focused, as far as visual observation went, gave a blurred image on the sensitive plate. A lens giving such a result was said to have the visual and "chemical" or actinic foci non-coincident. This is very rare in modern lenses, even of the cheaper class. (*See also* "Lens.")

ACTINOGRAPH

An instrument for estimating the exposure necessary for a photographic plate, invented by Hurter and Driffield. It embraces no new principle, but is simply a kind of slide-rule for arriving at a result without calculation in a manner precisely similar to that which was adopted in the exposure tables that were published by W. K. Burton and other pioneers of modern photography. It consists of two parts, a light scale and a scale of subjects, plate speeds, and lens apertures. The light scale is based on the fact published by Dr. Scott about 1880 that in clear weather the actinic value of the light varies in direct proportion to the height of the sun above the horizon. For example, the altitude of the sun is nearly four times as great in mid-summer as in mid-winter, and little more than one-fourth of the exposure is necessary in the middle of June when compared with that of December. In practice its use is less satisfactory to the ordinary worker than the exposure meter.

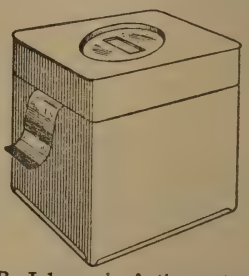
ACTINOMETER

An instrument for gauging the depth of printing in those processes in which little or no visible image is produced by exposure to light; known



A. Actinometer with Paper Scale

also as a print meter. There are two types of actinometers, differing both in character and in method of using. The essential feature in each, however, is that a piece of silver printing-out paper is exposed to light until a certain effect is produced, and by this the correct printing of the invisible image can be estimated. The older and simpler pattern consists of a small box with an opaque cap or lid, in which is a small opening. At one side of this opening is a small square painted in a medium dark colour to resemble as closely as possible the colour that silver paper assumes *and passes* during printing. It is essen-



B. Johnson's Actinometer

tial that this tint should be a medium tint in silver printing, and that the paper should pass the colour by continuing the exposure; otherwise it would be difficult to determine when the correct matching of the colour, or the correct time of printing, had been reached. A square or a strip of silver printing-out paper is placed under the lid and kept in fair contact by a pad. The actinometer is put out to print with the frames containing the carbon prints, and the small portion of the silver paper visible through the opening gradually darkens until it matches the printed tint at the side of the opening. The time necessary for this is called "one tint." As soon as one tint is printed the silver paper is moved forward and a second tint printed, and so on until the prints are completed. Experience alone can determine how many tints will correspond with the correct exposure for any print; as negatives and actinometers vary considerably. With this form of actinometer each succeeding tint need not always be exposed immediately the preceding one is printed if the light is uniform. The time of matching the tint may be noted, and three or four succeeding tints timed from that.

The second form of actinometer is more simple in use, and more suitable for the amateur worker. It consists of a series of squares of varying density—practically a test negative—and is used exactly as an ordinary negative. These squares range from one very thin up to a density equal to that of the sky in a very strong negative, and they are numbered consecutively to facilitate reference in printing. If a piece of silver paper is exposed to light under this test plate, a short exposure will show a faint image of the first two or three squares, and with a longer exposure more of the squares will be visible on the silver paper. The squares are surrounded by an opaque margin to render the image more plainly visible. The actinometer is put out to print at the same time as the frames containing the carbon prints, and each is brought in when the number considered correct for that negative is reached on the actinometer. The actinometer is examined occasionally, and the "number" that is considered printed is the square bearing the highest number that can be seen. Of course, a very faint image of that square is all that will be visible, the lower numbers, that have been fully printed for some

time, being seen as darker squares. These darker squares assist in determining the highest number visible—the faintest square that can be seen. One actinometer will serve for several frames, provided that all are put out at the same time.

In process work, various forms of actinometers are used for timing the printing of the image on the plate when exposed to daylight. The simplest form is that shown at A, consisting of a series of thicknesses of tracing paper bearing a number corresponding to the layers underneath. Another form has a glass scale bearing a Woodbury film, the pigmented gelatine graduating in thickness from transparency to opacity. Burton's actinometer consists of a series of six tiny negatives made by the carbon process. The negative to be printed can be compared with these, and a corresponding exposure given. This form of actinometer is very useful for collotype and photogravure work. Johnson's actinometer B is chiefly used for carbon printing. It only registers one tint, which is compared with a suitably coloured mask. If more than one tint is required to complete an exposure, the sensitive paper is shifted to a fresh position. The Sanger-Shepherd fraction tint actinometer consists of a scale of densities on a quarter-plate glass which is put into a printing frame and a piece of sensitised paper exposed behind it. It is very useful for timing the bichromated films in colour transparency work and for carbon printing, but it can be applied to any other process in which the exposure has to be accurately timed.

ACTINOMETRIC (Fr., *Actinométrique ;* Ger. *Aktinometrisch*)

Pertaining to actinometers, or to the measurement of the chemical, or actinic, power of light. Actinometry is the branch of science that deals with the numerous methods of testing the chemical activity of light, and which makes a study of the variations in its intensity in different quarters of the globe, or at different seasons and hours.

ACTINO-POLYCHROME (Fr., *Actino-Polychrome ;* Ger., *Farbenphotograph*)

An early name for a photograph in natural colours.

ACTION

More often than not, action is rendered in an unsatisfactory manner by photography, although this does not apply to cinematograph renderings. A person's mental impression of a man walking, a horse running, and so on, is the result of a blending of all the different positions assumed during the action. A single photograph naturally records but one position, and inadequately suggests the idea of action (*see* "Chromo-photography").

What is known as an "instantaneous" picture of a railway train or other object in rapid motion will not convey the impression of speed if it shows, for example, the spokes of the wheels sharply defined ; rather would it suggest suspended motion. O. G. Rejlander once well exemplified this in a couple of photographs of a lady at a spinning wheel. In one, the foot and spokes were of microscopic sharpness ; in the other, the foot and wheel were slightly blurred by intentional movement. Yet it was the second that gave the better impression of an "instantaneous" picture and the more complete suggestion of action.

ADAMANTEAN

An old form of ferrotype plate, largely used for the wet collodion process.

ADAMANTINE PROCESS

A secret process of half-tone etching on copper invented by A. C. Austin in the United States. It produced an extremely hard black enamel resist image for etching. Probably it was a modification of the fish-glue process, but no details have been published.

ADAPTERS (*See* "Plate Adapters" and "Lens Adapters.")

ADHESIVE TISSUES

Thin sheets of paper prepared, generally by the use of shellac, for use in the dry-mounting process.

ADIACTINIC (Fr., *Inactinique ;* Ger., *Unactinisch*)

Non-actinic ; a term sometimes applied to the red or orange glass and fabric used to screen the light in a dark-room. No light, however, is absolutely non-actinic, since any light, whatever its colour may be, will affect a photographic plate if sufficient time is allowed. Photographs have, in fact, been taken by the light obtained from a ruby lamp, although the exposure was, necessarily, very prolonged. For this reason, the plate should not be unduly exposed to the light of the lamp when developing, however "safe" it is believed to be. The "safety" of any so-called non-actinic glass or fabric is merely relative, and much depends on the nature of the plate or paper and its particular colour-sensitiveness. Thus, a yellow fabric or material that is quite safe for developing bromide papers will instantly fog a rapid dry plate ; while even a deep ruby light will have a marked effect on a panchromatic plate.

ADIAPHOROUS (Fr., *Adiaphore ;* Ger., *Adiaphor*)

Neutral ; a chemical term, sometimes applied to substances that are neither acid nor alkaline.

ADON

A low-power telephoto lens, especially suitable for hand-camera use. The positive lens is placed in front of the ordinary lens of a camera, in this way producing an enlarged image without abnormal extension of the camera or substantial reduction of the working aperture of the lens.

ADUROL (Fr. and Ger., *Adurol*)

A developer intermediate in character between the short factor developers, such as pyro and hydroquinone, and the longer factor developers such as metol, rodinal, amidol, etc. ; introduced in 1899. It is a mono-chlor (or mono-brom) hydroquinone. Adurol-Hauff has the formula $C_6H_3Cl(OH)_2$, and Adurol-Schering $C_6H_3Br(OH)_2$

—their actions being similar. The developer as purchased is in the form of a white or greyish-white crystalline powder, readily soluble in water and alkalis. In its action and results it resembles hydroquinone, but it is more soluble, keeps better, and the negatives are slightly softer. The addition of potassium bromide as a restrainer has not much effect, and the developing action is not much slower when the solution is cold. Since its introduction many formulæ have been published for one-solution, two-solution, and three-solution developers. The following are those in most general use :—

Sodium sulphite	8 oz.	400 g.
Potass. carbonate	6 ,,	300 ,,
Water	20 ,,	1,000 ccs.

Shake till dissolved, then add—

Adurol	1 oz.	100 g.

For negatives and gaslight paper dilute with 3 to 5 parts of water; and for bromide prints with from 7 to 10 parts of water.

The above is a one-solution developer, and may be used over and over again. The formula for the two-solution developer is :—

No. 1.	Adurol	85 grs.	17 g.
	Sodium sulphite	1¾ oz.	175 ,,
	Water to	10 ,,	500 ccs.
No. 2.	Potass. carbonate	1¼ ,,	125 g.
	Water to	10 ,,	500 ccs.

For use with plates and gaslight paper mix 3 parts of No. 1 with 2 parts of No. 2; for bromide prints add an equal quantity of water.

A three-solution adurol developer is as follows :—

No. 1.	Sodium sulphite	650 grs.	130 g.
	Adurol	80 ,,	16 ,,
	Water to	10 oz.	500 ccs.
No. 2.	Sodium carbonate	100 grs.	20 g.
	Water to	1 oz.	50 ccs.
No. 3.	Potass. bromide	48 grs.	10 g.
	Water to	1 oz.	50 ccs.

For soft negatives mix 1 oz. of No. 1, 310 minims of No. 2, and 20 minims of No. 3. For more brilliant negatives use 10 drms. of No. 1, ½ oz. of No. 2, and ½ drm. of No. 3. The three-solution formula is best for time-exposed plates, and when over-exposure is suspected.

Adurol combines well with metol and gives a developer which acts like metol-hydroquinone. One formula is :—

Metol	130 grs.	13 g.
Adurol	1 oz.	50 ,,
Water to	20 ,,	1,000 ccs.

Dissolve and add gradually—

Sodium sulphite	7 oz.	350 g.
Potass. carbonate	4½ ,,	225 ,,

For negatives and gaslight papers, dilute with 10 times the quantity of water; for bromide prints, with 15 times the quantity of water, or take of the stock adurol-metol developer as above 1 drm. and sufficient water to make 2 oz., and add a little bromide.

Adurol is the best developer for obtaining warm tones on bromide paper by direct development. The concentrated one-solution developer as given above (let it be called A) is used with three others—namely, 10 per cent. solutions of potassium bromide, B; ammonium bromide, C; and ammonium carbonate, D. The colours are obtained by altering the exposures and varying the proportions of the four solutions.

ADVERTISING, PHOTOGRAPHY IN

Photographs are extensively resorted to in the production of effective pictorial advertisements reproduced by the half-tone process. They are only occasionally used in the form of straight prints, but are nearly always "worked up" by skilled artists into what are actually monochrome wash drawings. Frequently the advertiser wants ideas rather than technically good prints, and he has at his command the services of men who can work up the poorest print until the desired effect is arrived at. So much work, in fact, is generally done by the artist that the photographer may easily fail to recognise the finished picture. A plan frequently adopted by the artist is to cut away the background, paste as much of the print as required on white cardboard, and then "work up" by means of the air-brush, etc., introducing suitable wording, etc. Often only the head is used from a photograph of a model, there being always a fairly brisk demand for studies of pretty ladies and children; but in submitting pictures to advertisers care should be taken about copyright matters (*see* "Copyright"), as any error on the part of the photographer may possibly put the advertiser to much trouble and expense. It is courteous, and often necessary, to obtain the model's permission to use his or her photograph in the proposed manner. Rough prints of suitable subjects should be submitted to advertisers with the intimation that, if desired, enlargements will be supplied upon bromide paper for working up. More often than not it is a waste of time on the photographer's part to work up a photograph according to his own ideas, and it is better to submit an untouched print and to leave the rest to the advertiser's artist.

AERIAL FOG (*See* "Fog.")

AERIAL IMAGE (Fr., *Image aërienne*; Ger., *Aetherisch Bild*)

A properly corrected lens produces, as it were, an aerial model at its focus of the scene at which it is directed. Each portion of this model is at the same relative distance from other portions as are the corresponding parts in the scene itself. Different parts of this aerial model are brought into focus on the ground-glass screen as the lens is racked in or out, so that the picture shown on the screen and recorded by the plate may be regarded as a section, vertical to the axis of the lens, through the many light rays which constitute, or proceed from, the aerial model. Owing to the coarse grain of the ground-glass screens at first supplied with photographic apparatus, it used to be thought that critical focusing could only be accomplished when the aerial image is directly inspected, which could be done by means of a telescope attached to the camera and arranged to focus simultaneously with it, or by having a transparent spot on the

focusing screen, made by cementing a microscopic cover glass on the latter with Canada balsam. This idea is theoretically correct for obtaining the greatest possible sharpness; but general satisfaction is now given by the definition obtainable by the ordinary method of focusing, especially if finely-ground glass is used. Ground glass of quite superior fineness is now procurable which, in conjunction with a really good lens, should remove most of the difficulties met with by earlier workers. An advantage of the telescope attachment was that it enabled moving objects to be followed, with the plate in position ready for exposure, a result now achieved more conveniently by the use of a reflex camera.

AERIAL PERSPECTIVE

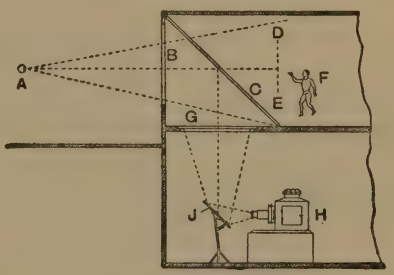
A gradual softening down as objects recede into the distance, whereby they lose strength both in colour and in light and shade. Very distant objects are often seen as a mass of light grey without detail. A print which successfully renders this is said to possess "atmosphere," and the suggestion of space and air is of very great value in pictorial work. The use of orthochromatic plates in conjunction with deep colour screens frequently destroys aerial perspective to a greater or less extent.

AERIAL PHOTOGRAPHY

The art of taking photographs from aeroplanes, airships, balloons, kites, etc. Very quick exposures are necessary because of the movement and of the great flood of light. Photographs were first taken from a balloon by Nadar, of Paris, in 1858, since when photography from balloons has been practised in war time very considerably, particularly during the American and South African wars. In balloons, airships, etc., the operator holds the camera, but in kite work the shutter is released by means of a cord held by the operator on the ground as explained under the heading "Kite Photography," where details of working will be found. The best photographs from balloons are, according to the late Rev. J. M. Bacon, those taken at an elevation of between 250 ft. and 4,000 ft. At a greater height than 4,000 ft. it ceases to be worth while to use the camera, since the particles of water and dust suspended in the atmosphere spoil the definition and sharpness of the pictures. M. Antonin Boulade, the eminent French authority on the subject, has advocated orthochromatic plates, and those sensitive to rays chiefly between the G and F lines. The choice of a screen is also of the utmost importance, and the best results in his opinion were those obtained with a two or three "times" screen. From great altitudes, where the action of the blue of the sky is very intense, yellow screens needing about six times the normal exposure produce the best negatives.

AERIAL SCREEN (Fr., *Écran d'air;* Ger., *Windschirm*)

A form of screen for giving relief and other effects for optical lantern pictures, its special object being to arrest the light coming from a lantern and to reflect it back to the point at which the projected image is to be observed. The "Bruce" aerial screen consists of a white lath, turning on a vertical axis in a plane parallel with the lantern lens. The mechanism and the rotating lath occupy a position in front of a black velvet screen or background, which absorbs all rays of light not falling on the lath and thus prevents them from reaching the eye of the observer. An ordinary optical lantern projects the subjects, which are preferably pictures of statuary in which fine photographic quality is present, giving as much rotundity as possible, and having a black background. The revolving lath, which takes the place of the ordinary lantern sheet, is caused to rotate at a moderate speed, calculated to make one revolution within the time needed to satisfy the laws of persistence of vision. Viewing it in broad daylight as it is rotated at the specified speed, it would present the appearance of a transparent cylinder. When the apartment is darkened and the picture is projected upon the rotating lath, the subject presents a somewhat solid aspect, and the audience will not be conscious of a revolving device, the illusion being caused by light from all parts of the image impinging upon the lath as it arrives at each and all of its positions. In virtue of the law of persistence of vision, there-



Producing Illusion with Invisible Screen

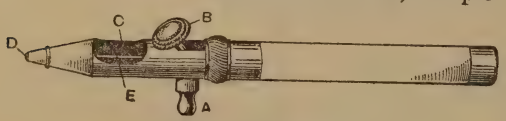
fore, a complete image will be made up. The chief object of this form of aerial screen is to bring about relief, but naturally a full stereoscopic effect is not obtained in this way. Another form of aerial screen consists of a column of vapour rising from the ground and acting as a reflector of the projected rays of light, just as a cloud in the sky may reflect the rays of the sun, but as the medium cannot be controlled as regards its reflecting surface it is only useful for producing weird effects in which absolute definition is not a necessity.

Yet another and much more recent form of aerial screen is that in which the laws of partial reflection are made use of; it is termed "the invisible screen," because the medium upon which the image is actually received is hidden from the observer's view by the front of the proscenium. A method of reflection somewhat similar to that used in the old illusion known as "Pepper's Ghost" is adopted, but there are variations in the arrangement of the apparatus which make the results far more perfect and realistic. An observer situated in the auditorium at A (*see* the illustration) looks towards the proscenium B, and sees in a clear plate glass C the aerial image D E, and at the same time observes at F any actors (real persons) who may be performing. The light rays constituting the

spectre D E are arrested before reaching the glass C by a semi-transparent screen G. In the basement under the stage an ordinary optical lantern, or a kinematograph projector H, is set up. A mirror J, placed at an angle of 45 deg. in relation to the optical axis of the lantern objective, diverts the light from its horizontal course into a vertical direction, so that the defined picture or image is received upon the semi-transparent screen G. In virtue of the angle of reflection being equal to the angle of incidence, whatever may be projected on C will be seen by the observer at A, and will appear to be situated in mid-air in the vicinity of F. Hence, the so-called "invisible screen" may be regarded as the aerial screen, although the aeriograph is seen in quite a different place. The chief object of the invisible screen in this case is to afford means for producing aerial images or spectra in combination with real actors; whilst by the use at H of a kinematographic apparatus instead of an ordinary lantern many startling effects, otherwise impossible, are produced.

AEROGRAPH, OR AIR BRUSH (Fr., *Aérographe*; Ger., *Aerograph*)

A mechanical sprayer working by means of compressed air, and used for finishing and working up both prints and negatives; invented by Charles L. Burdick, of Chicago, in 1892, and introduced into England a year later. It is capable of great technical possibilities, and produces effects varying from peculiarly soft and beautiful graduations to strong and vigorous work. At will, and in successive instants of time, the operator can draw lines or wide bands of colour, and shadows, either soft and delicate, or hard and coarse. The complete outfit includes the handpiece, or fountain air brush, an air pump with compressed air reservoir, an air pressure-gauge, rubber tubing, liquid colour, etc.; inasmuch as a high and uniform air pressure is essential to the best results, a motor-driven air pump is superior to the foot-operated one, and both kinds are manufactured. Cylinders of compressed carbon dioxide ("carbonic acid gas") may be used in place of the pump with equal convenience. When using the foot pump the pressure obtained is about 15 lb. per square inch, and when using the motor pump from 30 lb. to 40 lb. per square inch, this producing a much finer grain.



Aerograph Handpiece

The illustration shows the appearance of the aerograph. Air is pumped into a chamber connecting with the handpiece by means of a rubber tube at A. Finger pressure on a button B opens a valve and admits the air, which sucks the liquid colour from the reservoir C and throws it from D in the form of a fine spray, over which the operator has complete control. The spray is regulated and stopped by a needle-like rod E worked by B.

In the management of the aerograph, scrupulous cleanliness is always necessary. Keep the pencil in the case when not in use, and before fitting it up for service, pump air into the cylinder, squeeze the tube for a moment or so, and then release so as to allow the dust inside the tube to blow out. Use the colour thinly, and go over the work several times to get a fine, even grain. Use fresh colour for every occasion, and change the water frequently to avoid dust, which otherwise will cause the colour to splutter. Before and after using the instrument, pass two or three lots of clean water through it, and clear away any accumulation of paint with a wet brush. To adjust the needle, just fit it easily to the platinum point where the valve lever is as far forward as it will go. Do not jam it hard and push far in, otherwise too much colour will be ejected on pressing down the valve. Also see that the rubber tubes are free from kinks or bands. Having mixed the colour in a clean saucer, transfer to the reservoir by means of a brush. Spray a little in the air before treating the original, to make sure that all the cleaning water is expelled and the brush is working properly. Hold the aerograph about 6 in. distant from the original, press the lever down and slightly backwards, move it horizontally with a gliding sweep from left to right, beginning at the top left-hand corner, and releasing the valve at the end of each journey until it has travelled in this way downwards over the whole space to be covered. The air brush unaided does not produce sharply defined lines and edges; paper masks must therefore be used to obtain these, or if the background has merely to be painted out, then the parts that are to be protected can be covered over with a special preparation, "Masklene," supplied by the makers of the aerograph; the colour is sprayed on, and the protected parts are then cleaned with a pledget of cotton wool soaked in benzine.

In process work, the aerograph is extensively employed for working up originals for reproduction, especially photographs of objects for catalogue illustration. Backgrounds are in most cases put in with the aerograph and vignetted off. Sometimes the main object is cut out of the photographic print with scissors or a sharp knife, then mounted on cardboard, and a background and other detail put in. Another method largely adopted is to stop out portions on which the aerograph spray is not to be applied, the stopping-out medium being of such a nature that it can afterwards be removed without injuring the rest of the drawing. The medium used may be either of a greasy nature, such as vaseline, which may be afterwards cleared away with benzol, or it may be a celluloid varnish, which may be removed with amyl acetate or other solvent of celluloid. India-rubber solution and yolk of egg are other substances used for the same purpose. The former can be peeled off by rubbing with the ball of the finger, whilst the latter will flake off. In either case the colour applied by the aerograph comes away with the medium, and leaves quite clean the portions which have been covered. Larger surfaces may be stopped out by cutting out masks of tracing paper and attaching these

temporarily to the print with rubber solution. The colours used should be mixed to match as nearly as possible the tints of the original to be worked up. Chinese white should be avoided, as it photographs darker than the white papers on which it is applied. Albanine, Ullmanine, and Blanc d'Argent are good whites to use for this work. Lampblack and "process black" are the blacks commonly employed. For large lithographic work, such as posters, a larger hand-piece is employed, which will give a coarser spray and will not clog with the transfer ink necessitated by the lithographic process.

AEROMETER

A hydrometer for measuring the density of acids.

ÆSCULIN (Fr., *Æsculine;* Ger., *Æskulin, Schillerstoff*)

Synonyms, esculine, esculin, esculinic acid, polychrome, bicolorin, enallachrom. An extract obtained from the bark of the horse-chestnut (*Æsculus Hippocastanum*). $C_{15}H_{16}O_9$. Molecular weight, 340. A white powder, a solution of which, of a strength of about 1 part in 500 parts of water, is used as a filter to absorb ultra violet rays.

In process work, where the white (particularly Chinese white) reproduces as if it were yellow, an æsculin filter should be used. This may be a solution contained in a glass cell having parallel sides, or it may be in the form of a dry filter.

AGAR-AGAR, OR AGAL-AGAL (Malayan) (Fr. and Ger., *Agar-agar*)

A gelatinous vegetable material obtained from certain white seaweeds (*Gracilaria lichenoides* and *Eucheuma spinosum*), found principally on the shores of the Red Sea. It is used to a small extent as a substitute for gelatine in plate and paper making, but it is more difficult to melt than gelatine, and is not generally so satisfactory for emulsion work. It has also been recommended as a substitute for arrowroot in the preparation of silver paper, the latter, if very porous, being first sized with a 1½ per cent. solution of gelatine. Five parts of agar-agar are allowed to soak for an hour or two in 500 parts of water, heated till dissolved, boiled for five minutes, and then mixed with twenty parts of common salt and strained through a cloth. It is carefully brushed on the paper, and this, when dry, is floated in the dark upon a 14 per cent. solution of silver nitrate containing 10 per cent. of citric acid. In the case of thick and coarse paper, the silver solution is first brushed on, and then, when dry, the paper is floated on the agar-agar solution and again dried in the dark. After being sensitised the paper keeps well. It is printed and toned as other plain silver papers, but if platinum is used as a toner the picture must be deeply printed.

In process work, agar-agar has been suggested as a substitute for fish glue in the enamel process of preparing the resist for etching, but it has not come into commercial use.

AGATE BURNISHER

A burnisher consisting of a polished piece of agate fitted to a handle; it was used in the original method of burnishing albumen prints. The unmounted print was laid on plate glass or marble and polished with the burnisher. The operation was thought to cure "measles" on prints, and give depth to the shadows. The process was rendered obsolete by the introduction of the burnishing machine.

AIR-BELLS (*See* "Bubbles.")

AIR BRUSH (*See* "Aerograph.")

AIROSTYLE

A form of air brush, introduced in 1907.

AKTINAL (Fr., *Actinal*)

A preparation sold in Germany as a desensitiser for exposed plates, after treatment with which they may safely be developed in daylight, using a metol-hydroquinone developer, with caustic potash as the accelerator, and fully restrained with potassium bromide. It is said to be a 4 per cent. solution of potassium iodide.

ALABASTER, OR ALABASTRINE, PROCESS

A very old process for improving the quality of positives made on glass by the wet collodion process. The picture was bleached in a solution of mercuric chloride in order to increase the brilliancy of the white image, was then varnished, and finally, when dry, was bound at the back. The process is even now occasionally used in obtaining a good result from a thin gelatine negative, which must be free from fog. The faulty negative is bleached in a solution of mercuric chloride, washed, dried, backed with black material, and copied in the camera. Ready-made mercury solutions for the process have been sold under the name of "alabaster" solutions. The original formula is: Water, 2 oz.; nitric acid, 60 minims; hydrochloric acid, 60 minims; to which must be added sufficient mercuric chloride to saturate the solution, the excess remaining in crystals; finally, 60 minims of alcohol must be added. A more modern mixture—and one equally suitable for dry (gelatine) plates—is: Water, 2 oz.; bichloride of mercury, 40 grs.; hydrochloric acid, 1 drm.; sodium chloride (common salt), 20 grs.; and sulphate of iron, 20 grs. Wet collodion pictures bleached with this are permanent if varnished, and so protected from the atmosphere, but dry plate negatives thus bleached will not remain white for long if kept in a strong light.

ALBANINE

A very pure white water-colour pigment used by process retouchers for working up originals either by brush or with the aerograph. It photographs as white, and should be employed pure for brilliant touches in the highest lights of a drawing or print. It can be mixed with "process black" for obtaining graduations of shadow. No other white should be mixed with it.

ALBERINI'S PROCESS (*See* "Asphaltum.")

ALBERT PAPER (*See* "Photo-Lithography.")

ALBERT'S COLOUR PROCESS (*See* "Cito-chrome.")

ALBERT'S RELIEF OR GALVANO PROCESS (Fr., *Méthode à rehausser d'Albert;* Ger., *Albert's Unterlage*)

A method of imparting a varying relief to the surface of printing blocks, so as to avoid the necessity for overlaying to bring up the darker portions in typographic printing; invented by Dr. E. Albert, of Munich. A heavily inked proof is taken from the plate, and transferred to a thin zinc plate. The ink image is strengthened by dusting with resin or bitumen powder and heated to fuse the powder and ink. Then the plate is etched strongly until the highest lights are etched away, and the half-tones partially, the shadows remaining solid and, consequently, in the highest relief. This plate is covered with a sheet of thin gutta-percha, and the back of the original plate placed on it in exact register, the whole being then put into a heated press, with a soft packing over the face of the plate. On strong pressure being applied the underlay plate is attached to the original plate, and the undulations of surface on the former communicate relief to the latter plate. The combined plate is mounted on wood or metal to type height, and is then ready for printing, no "making-ready" by the printer being necessary.

ALBERTYPE, ALBERT-TYPE, OR ALBERTOTYPE (Fr. and Ger., *Albertypie*)

The first workable collotype process made known; invented by Josef Albert, of Munich. It differs somewhat from the present-day collotype process. A piece of glass $\frac{1}{8}$ in. thick is coated, in a dark-room, with the following solution:—

Water	300 parts.
Albumen	150 ,,
Gelatine	15 ,,
Potassium bichromate .	8 ,,

When the film is dry it is exposed to light for two hours *through the glass*, backed by a piece of dark cloth, so that the film may harden from the bottom (next the glass) to the surface. The exposed plate is now coated with the following:—

Gelatine	300 parts.
Potassium bichromate .	100 ,,
Water	1,800 ,,

When again sufficiently dry the plate is exposed from the coated side under a negative, and is then washed for fifteen minutes, and dried. The film is next damped, and inked in the usual way. Printing is done in a lithographic press, or in a proper collotype press. The process is said to give prints with fine half-tones, but it requires considerable care and experience in manipulation, much depending on the printing.

ALBUM (Fr. and Ger., *Album*)

Blank-leaved books for storing and displaying photographic prints. They may be roughly divided into two classes—slip-in and paste-down. As the names suggest, the former has a double page with cut-out openings on the upper leaf so that the prints (generally glazed) may be slipped in between the two sheets; the latter has plain pages on to which the prints are pasted. The colour of the leaves is important; white is generally unsuitable, and bright tints should be avoided. It is also important when prints are to be pasted down to make sure that both paper and adhesive are free from acid or anything that will be deleterious to the photographs. Prints do not show to the best advantage when many are crowded together on one page. A print that is worth mounting at all deserves to be presented alone on a separate page, of a tint that is harmonious and unobtrusive. Special albums are made for the storage of film negatives, thus affording an easy means of indexing and reference.

ALBUMEN (Fr., *Albumine;* Ger., *Albumen*)

A very complex organic compound containing carbon, hydrogen, oxygen, and sulphur, which occurs both in the animal and vegetable kingdom. Animal albumen exists as the serum or white fluid of blood, but photographically the white of eggs is the only animal albumen used. To prepare it for photographic purposes the whites of eggs should be separated from the yolks and the germ, and thoroughly beaten to a froth, allowed to settle for twelve or twenty-four hours, and then filtered. Actually, the albumen is contained in minute cells, and the beating has the purpose of breaking the cell walls, which subsequently form the flocks or scum.

Albumen is coagulated by heat (150° F. or 65·5° C.), by alcohol, and most metallic and inorganic salts, the resultant precipitate with the latter being albumenates. It is an almost colourless, gummy liquid, which dries to a pale yellow solid. Seventy grains of the dried egg albumen dissolved in one fluid ounce of distilled water forms a solution equal to the fresh white of egg. The solution is extremely liable to decomposition, and should be either freshly prepared or preserved with an antiseptic. It is used for albumenised paper, the albumen negative, beer, and positive processes.

Invert albumen is obtained from ordinary albumen by first treating with acid and then with alkali, by which treatment it is so altered in character that it becomes soluble in alcohol. The following process has been suggested by Sanger Shepherd:—

White of eggs .	20 oz.	1,000 ccs.
Glacial acetic acid .	148 mins.	16·5 ,,

Beat up thoroughly, and allow to stand for one hour, then add a 20 per cent. solution of sodium hydrate drop by drop with constant stirring till the mixture thickens; next allow to stand for one hour, break up into small pieces, and wash (*see* "Emulsion"), drain well, and dissolve in boiling alcohol. Invert albumen gives an extremely tough, structureless film, and was suggested for making colour filters.

In process work, albumen is used as a substratum, or for edging the glass plates in making wet plate negatives. Also, it is almost universally employed with potassium bichromate for sensitising the zinc plate for photo-etching. Albumen is also often mixed with fish-glue in making up the enamel solution for printing on zinc or copper from half-tone negatives. Dried albumen is frequently employed in preference to the liquid white of eggs. Varying opinions are expressed as to the quantity of dried albumen

required to equal the albumen of one egg, but 70 grs. to 1 oz. of water may be taken as a safe standard.

ALBUMEN PROCESS

NEGATIVES.—An old process invented by Niepce de St. Victor, in 1848. Glass was coated with albumen containing potassium iodide, and the film was sensitised by dipping in a nitrate of silver bath. Many modifications followed, but probably the process most widely used was the one published on May 21, 1855, by Mayall; this comprised six distinct operations, as follow:—

(1) The albumen (white) of a fresh egg is beaten to a snow-like mass with a bunch of quills, afterwards dropping into it 10 drops of a saturated solution of potassium iodide and allowing to stand six hours at a temperature of 60° F. (2) A piece of plate glass having smooth edges is cleaned by rubbing over it nitric acid with cotton wool, and polished with Tripoli powder moistened with a few drops of a concentrated solution of potassium carbonate. To the centre of the back of the glass is attached a pneumatic holder to serve as a handle. (3) The prepared albumen is strained through linen, and is then used to coat the polished side of the glass, this being placed on a level slab in a warm and dustless place to dry. The glass is now known as the "iodo-albumenised" glass, and it will keep in a good condition for any length of time. It may be prepared in daylight. (4) The sensitising mixture, or "exciting solution," is made by dissolving 50 grs. of silver nitrate in a mixture of 1 oz. of distilled water and 120 minims of strong acetic acid, which operation and the following one must be done in a weak yellow light. Pour the sensitising mixture into a clean porcelain dish a little larger than the plate to be coated; place one end of the albumenised glass in the solution; with a quill, support the upper end of the glass and let it fall suddenly into the solution, lifting it up and down for ten seconds; take it out, and place it face upwards in another dish half filled with distilled water; allow the water to pass over the surface twice, take out and set aside in the dark to drain and dry. The plate at this stage is ready for exposure in the camera, and will keep good for ten days if kept from the light, in a moderately warm place, and free from moisture. The surplus sensitising solution may be filtered back into a black bottle for use again and again, adding occasionally a few drops of acetic acid and keeping in the dark. Exposure varies from four to ten minutes, according to light and stop. On a very bright day, and using the *f*/16 stop, Mayall recommended an exposure of five minutes. (5) For development, the glass is placed film side upwards on a levelling stand, and a concentrated solution of gallic acid is poured over it; the image takes from thirty minutes to two hours to develop. A temperature of 10° higher than that of the room is advised, and if the image is feeble the plate is rinsed and covered with a solution of equal quantities of aceto-nitrate of silver and gallic acid diluted with water to half strength. This causes the image to appear more quickly and stronger. The plate is next washed in three waters, and is then ready for fixing. (6) The fixing solution is made by dissolving 3 drms. of hyposulphite of soda in 1 oz. of water. The plate is allowed to remain until all the yellow iodide has disappeared, and is next well washed and dried. "Success," said Mayall, when publishing this process in the *Athenæum* (No. 1,220), "is sure to attend anyone practising this method, provided the eggs are fresh and the glass quite clean; if the glass is not clean and the eggs stale, the albumen will split off the plate during the fixing." Among the modifications which followed for the purpose of quickening the plates were the addition of grape sugar, honey, and potassium fluoride, the latter proving to be the best of all. Malone's and other processes in use in the 'fifties of the nineteenth century differed in detail from the above, but in essentials were the same.

POSITIVES.—At one time the albumen process was widely used for the production of positives or lantern slides, and even at the present time, owing to the exquisite results obtainable with it, the albumen process is used by some of the largest lantern and stereoscopic transparency firms in the world. It is hardly a process for the beginner, because of the somewhat complicated formulæ and manipulations. The famous "Ferrier et Soulier" slides were produced by the albumen process, but the exact formula used was kept secret. Other formulæ have, however, been published and worked successfully, the best being that in which the plate is coated first with collodion and then with iodised albumen; the details are as follow: Pieces of good clear glass should be thoroughly cleaned by washing in a solution of 8 oz. of soda in 1 gal. of hot water, and rubbing well with rags tied to a wooden stick. Next, the plates are rinsed in plain water and placed in dilute hydrochloric acid (1 in 20). A substratum is next required, and this is made by mixing the white of one egg with 50 oz. of water; the mixture being shaken up three or four times during the day and allowed to stand all one night, it is then filtered through fine muslin. The plates are taken from the acid bath, rinsed, drained slightly, and coated on one side with the albumen substratum mixture; next they are laid flat and dried. Great care is necessary to avoid dust and to get an even coating. When dry, collodionising and sensitising may take place. Some ready-made iodised collodion is obtained (the longer it has been iodised the better), and the following solution is prepared:—

Distilled water . .	20 oz.	1,000 ccs.
Silver nitrate . .	2 ,,	100 g.
Potass. iodide . .	2 grs.	.2 ,,

Shake well, stand in sunlight for a day, and filter into a glass dipping bath, when it is ready for use. The following albumen solution must also be prepared and kept ready at hand for use after collodionising:—

Albumen (fresh white of egg) . . .	8 oz.	800 ccs.
Liquor ammoniæ .	2 drms.	25 ,,
Potass. bromide .	10 grs.	.4 g.
Potass. iodide . .	50 ,,	2·0 ,,
Distilled water . .	3 oz.	300 ccs.

The albumen must be well beaten up with a silver fork, the bromide and iodide mixed with it, the water and the liquor ammoniæ being then added. The mixture should stand twenty-four hours before use, and then be filtered through muslin. Take one of the plates prepared with the substratum, coat with the iodised collodion, drain, and move to and fro in the air so that the ether may evaporate, place at once upon the dipper and immerse in the silver nitrate bath. A deep ruby light is not necessary, an orange or a deep yellow light being quite safe enough. The plate must be moved up and down in the silver bath a few times, allowed to stand for two minutes, taken out, the silver drained off, and then washed for a few minutes and drained, but not dried. While the surface is still damp the plate is covered with the albumen solution, drained, and again coated with the albumen. When dry, the plate must be treated in order to make the bromo-iodised albumen more sensitive to light, for which purpose the following bath is used :—

Silver nitrate (recrystallised)	600 grs.	60 g.
Distilled water to	20 oz.	1,000 ccs.
Glacial acetic acid	110 drms.	1 cc.

The plates are allowed to remain in this bath for two or three minutes, washed well, and flowed over with a nearly saturated solution of gallic acid, and finally dried in a warm dark place. The plates are then ready for exposing. The time of exposure will be about fifteen times as long as an ordinary modern gelatine lantern plate. Over- is better than under-exposure. The following pyro developer should be used :—

A.	Pyrogallic acid	96 grs.	100 g.
	Alcohol to	1 oz.	500 ccs.
B.	Potass. bromide	12 grs.	125 g.
	Water to	1 oz.	500 ccs.
C.	Ammonium carbonate	80 grs.	84 g.
	Water to	1 oz.	500 ccs.

To prepare the developer for use, 12 drops of A are mixed with 1 dram of B and 6 drams of C. The image soon appears, but will be thin and usually requires to be strengthened by redevelopment, which is done by applying a small quantity of the following developer, after washing off the first developer :—

Pyrogallic acid	6 grs.	4 g.
Distilled water to	3 oz.	85 ccs.
Citric acid	1½ grs.	1 g.

Before using this, add a few drops of a solution of 30 grs. of silver nitrate in 1 oz. of water. As soon as dense enough, the plate is fixed in a solution of sodium hyposulphite (4 oz. to 20 oz. of water), washed for about five minutes, and dried.

Many other formulæ have been advocated, some much more simple than the above and without the use of collodion, but the process described probably gives the most satisfactory results and offers fewer opportunities for failure.

ALBUMEN PROCESS (BEER)

A dry collodion process for solar photography, introduced by Sir William Abney in 1874, also of use for landscape work. Abney's formula is :—

Alcohol (·825)	4½–3 drms.	270–180 ccs.
Ether	3½–5 ,,	210–300 ,,
Pyroxyline	7 grs.	7 g.
Ammonium iodide	2 ,,	2 ,,
Cadmium bromide	5 ,,	5 ,,

The relative proportions of alcohol and ether are adjusted according to temperature. The plate is then sensitised in a silver bath of from 40 to 60 grs. per oz., and is next washed, and the first preservative applied :—

Albumen	1 oz.	100 ccs.
Water	1 ,,	100 ,,
Liquor ammoniæ	1 drm.	12·5 ,,

This is beaten to a froth and allowed to settle. The clear part is mixed with an equal quantity of flat beer or stout immediately before use, and is then applied to the plate; fresh bottled beer or stout must not be used. The excess is then drained off, the film washed for two minutes, and finally covered with a solution made by adding to every ounce of plain beer 2 grs. of pyrogallic acid. The plate is then dried in the usual way. Great latitude in exposure is permissible, even up to twenty times the correct amount, and, if desired, the plates need not be developed for a month, but they need to be washed just previous to development. For developing, four solutions are necessary :—

A.	Pyrogallic acid	12 grs.	12 g.
	Water	1 oz.	500 ccs.
B.	Liquor ammoniæ (·880)	1 drm.	62 ccs.
	Water	½ oz.	250 ,,
C.	Citric acid	60 grs.	60 g.
	Acetic acid	30 mins.	2 ccs.
	Water	1 oz.	500 ,,
D.	Silver nitrate	20 grs.	20 g.
	Water, distilled	1 oz.	500 ccs.

Three drops of B are mixed with each half-ounce of A, and flowed over the plate. The image will then gradually appear. Two more drops of B per half-ounce are added, the solution again flowed over the plate and returned to the measure. Six drops of C are placed in a measure, and the partially used developer poured on to it, afterwards adding a few drops of D. The application of this solution intensifies the image. Abney states that it is not advisable to bring out too much detail with the pyro-ammonia solution, but to allow some of it to be brought up at the finish with the intensifier. When the image is sufficiently dense, the plate is fixed either by a solution of potassium cyanide or with "hypo," then washed and dried. The process is not an easy one, and many failures are likely to be met with, but the resultant negatives, when all goes well, are of a remarkably high quality.

ALBUMEN PROCESS (PHOTO-MECHANICAL)

(*See* "Zinc Etching.")

ALBUMENISED PAPER

A prepared paper for obtaining prints from negatives. It is similar to plain salted paper, except that albumen is used with the first or salting solution in order to give the paper a gloss

PORTRAIT OF A. HADDON — BY FURLEY LEWIS, F.R.P.S.

STUDIO PORTRAITURE

and to keep the silver sensitising solution on the surface. The introduction of albumenised paper has been credited to Talbot, but definite instructions for making it emanated from other experimenters—notably Le Gray, Hunt, and Pollock—during the years 1851, 1852, and 1853. For about forty years albumen paper remained the most popular of all printing processes, and reigned supreme until the introduction of gelatino-chloride (P.O.P.) and similar papers. It, however, is still used by some professional workers and for some special processes, as crystoleum work, for example. Ordinary white papers were used at first, but in 1863 methods of slightly tinting the papers mauve, pink, etc., by means of dyes, were introduced.

ALCOHOL (Fr., *Alcool;* Ger., *Alkohol*)

Chemically, alcohols are neutral compounds formed by the replacement of hydroxyl OH for one atom of hydrogen in a saturated carbon compound; for instance, C_2H_6 ethylene gives C_2H_5 OH ethyl hydrate, or ordinary alcohol. They unite with acids with elimination of water to form ethers. Alcohols are hydrates of organic radicles and may be considered as equivalent in organic chemistry to the metallic hydrates in inorganic. For example, KOH potassium hydrate; C_2H_5 OH ethyl hydrate. They are divided into monatomic, diatomic, triatomic, etc., according to the number of OH groups attached to the organic radicle.

Alcohol, Ethyl (Fr., *Alcool ordinaire, Alcool éthylique;* Ger., *Aethylalkohol*)

Synonyms, ethylic alcohol, ethyl hydrate. C_2H_5 HO. Molecular weight, 46. Solubilities, miscible with water and ether in all proportions. A colourless, volatile, inflammable liquid of pleasant odour; it is obtained from grain, starch, or sugar by fermentation and subsequent distillation. It is principally used for preparing collodion (*which see*).

Absolute Alcohol contains from 98 to 99 per cent. of pure alcohol, and is used for making collodion.

Rectified spirit or spirits of wine contains 10 per cent. of water, and is known as 58 over-proof. The term "proof spirit" refers to an old test with gunpowder, which was moistened with the spirit and then a light applied; if the gunpowder fired the spirit was termed proof.

Alcohol, Methyl or Methylic (Fr., *Alcool méthylique;* Ger., *Methylalkohol, Holzgeist*)

Synonyms, wood alcohol, wood spirit, wood naphtha, methyl hydrate or hydroxide. CH_3 OH. Molecular weight, 32. Solubilities, miscible with water, alcohol, and ether in all proportions. A colourless, mobile liquid, prepared by the destructive distillation of wood. It is an excellent solvent for resins and pyroxyline, with which it gives a very tenacious film.

Alcohol, Methylated (Fr., *Alcool dénaturé;* Ger., *Brennspiritus*)

Synonyms, methylated spirit, denatured alcohol or spirit. Solubilities, miscible with water and ether in all proportions. It usually contains about 90 per cent. of aqueous ethyl alcohol with about 10 per cent. of methyl alcohol and ½ of 1 per cent. of mineral naphtha to render it unpotable. Industrial methylated spirit does not contain naphtha, and can only be obtained by special permit of the Inland Revenue under a heavy bond; it may be used for nearly all photographic purposes instead of pure alcohol, except for printing-out collodion emulsions. The admixture of methylated spirit with water turns it milky in consequence of the separation of the naphtha.

In process work, alcohol plays an important part. For making up collodion for the wet plate process, absolute alcohol of ·805 sp. g. is usually employed. Spirit of wine is used in the wet plate developer to overcome the repellent actions of the silver solution on the plate when the bath has become charged with alcohol through the frequent sensitising of plates. As the bath gets older the proportion of alcohol is increased. Methylated spirit is not generally employed on account of the presence in it of mineral naphtha, which is apt to give fog, scum, and other troubles, but industrial alcohol (wood spirit) may replace the pure spirit on the score of economy. In making up collodion emulsion only pure alcohol should be employed. Alcoholic solutions of dyes are largely used in colour sensitising, and in this case only pure alcohol should be used. Methylated spirit is used for drying off the fish-glue print after development. It is also employed for developing resinous images, for making up acid resist varnish, for diluting stopping-out varnish, and for cleaning off varnish coatings. In the aquatint process alcohol is used with resin to give the granular ground which is formed on the plate for etching. Similarly, alcohol is used in certain bitumen processes, such as the Frey process, where the alcohol with the asphalt causes the film to reticulate—that is, to form a network. An alcoholic solution of bichromate is used for sensitising carbon tissue, the object being to promote quicker drying.

ALCOHOLOMETER (Fr., *Alcoolmètre;* Ger., *Alkoholometer*)

A hydrometer graduated so that the percentage of alcohol can be read off directly on the scale.

ALDEHYDE (Fr., *Aldéhyde ordinaire;* Ger., *Aldehyd*)

Synonyms, acetaldehyde, ethaldehyde, acetic aldehyde. CH_3 CHO. Molecular weight, 58. Solubilities, miscible in all proportions with water, alcohol, and ether. A colourless, light, inflammable liquid, with pungent smell, obtained by oxidising ethyl alcohol with chromic acid. It was suggested by Lumière and Seyewetz as a substitute for the alkaline caustics and carbonates in developers, but it is rarely used. It forms, as does acetone (*which see*), compounds with the bisulphites, and its action in developers may be represented by the same equation.

In process work, aldehyde as an impurity in alcohol is often the cause of foggy negatives in wet collodion and collodion emulsion. The aldehyde may be detected by adding a small quantity of a strong solution of silver nitrate to the alcohol and exposing the whole to light for some hours, when the liquid will gradually blacken if aldehyde is present.

ALETHOSCOPE (Fr., *Alléthoscope;* Ger., *Alethoskop*)

An optical device invented by Signor Ponti, of Venice, and intended for the inspection of transparencies or ordinary photographic prints. It consisted of a large single lens, suitably mounted, somewhat after the manner of the modern lanternoscope or pantoscope used for viewing lantern slides. It was claimed that the alethoscope showed single photographs with stereoscopic relief, but that is a theoretical impossibility, although it is possible to obtain a deceptive approximation to relief when looking with both eyes through a large convex lens at a single photograph, provided the lighting, modelling, and perspective of the picture are good and natural; but this effect is more due to imagination and suggestion than anything else. If a coloured picture is used the illusion is heightened. According to Sir Howard Grubb, who investigated this effect as seen in the graphoscope, this is due to the lens being non-achromatic, so that it fringes everything with red on one side and with blue on the other. Thus the outline of, say, a red flower is a little extended on one side to the right eye and on the other side to the left eye, which causes the two pictures seen by the respective eyes to be really dissimilar, in such a manner as to give the appearance of relief when combined, although not properly stereoscopic.

ALGRAPHY

A process of lithographic printing from aluminium plates, as a substitute for lithographic stone, patented by Joseph Scholz, of Mainz, Germany. Aluminium had previously been used for lithographic printing, but Scholz was the first to make it a commercial process. His method chiefly relates to the preparation of the surface, phosphoric acid playing an important part in the process.

ALIZARINE, ARTIFICIAL (Fr., *Alizarine artificielle;* Ger., *Alizarin künstlich*)

Synonym, dioxyanthraquinone *α—β*. A group of organic dye-stuffs obtained from anthracene. The only one of importance is alizarin S, the sodium-bisulphite compound, which has been occasionally used for sensitising plates for red. Its action is somewhat uncertain, and it has been entirely replaced by the isocyanines (*which see*).

ALIZARINE, NATURAL (Fr., *Alizarine naturelle;* Ger., *Alizarin natürlich*)

Synonyms, madder, rubia. The root of *rubia tinctorum*, obtained from South Europe and the Orient, yields by extraction the colouring matter alizarine, which is used for making carbon tissue and in dyeing.

ALKALI (Fr., *Alcali;* Ger., *Alkali*)

The direct opposite to an acid. A term by which the accelerator used in development is often known. An alkaline solution is one that will turn red litmus paper blue, or change the yellow colour of turmeric paper to brown. Most of the modern developers for dry plates are known as alkaline developers because of an alkali—ammonia, soda, etc.—being used as the accelerator. In 1862 a Mr. Leahy, of Dublin, found that liquor ammoniæ assisted the pyro developer, but Major Russell, the inventor of the tannin process, had for some time been experimenting in the same direction, and in 1862 published the first complete account of a workable system of alkaline development. Since then alkalis other than ammonia—namely, sodium and potassium carbonates—have come into wide use. Previous to 1862 ammonia was largely used in America, but not in the developer itself; the plates were merely exposed to the fumes of ammonia before the pyro was applied.

ALKALIS, CAUSTIC

Potassium hydrate, sodium hydrate, and lithium hydrate are examples of the caustic alkalis, being often referred to, respectively, as caustic potash, caustic soda, and caustic lithia. Their caustic nature is easily demonstrated by the rapidity with which they will disintegrate the human skin. The carbonates are sometimes referred to as the "mild" alkalis to distinguish them from the hydrates or "caustic" alkalis. Caustic soda is, as a rule, purer than caustic potash, but both have an action upon glass, and render grease soluble in water. (*See also* "Caustic.")

ALKALIS, CHEMICAL EQUIVALENCE OF

All alkalis are not alike in their action as accelerators in developers, and one cannot be used in the place of another indiscriminately. The table below, compiled by George E. Brown, is the most widely used for finding the equivalent values of the alkalis:—

Caustic Soda	*Caustic Potash*	*Ammonia ·880 Solution*	*Soda Carbonate (anhydrous)*	*Soda Carbonate (crystals)*	*Potass. Carbonate (anhydrous)*	*Potass. Carbonate (crystals)*
80	112	97·14	106	286	138	174
1	1·400	·867	1·325	3·575	1·725	2·174
·714	1	1·211	·946	2·553	1·232	1·554
·834	1·153	1	1·091	2·944	1·421	1·791
·755	1·033	·916	1	2·698	1·302	1·641
·280	·392	·340	·371	1	·483	·608
·580	·812	·704	·768	2·072	1	1·260
·460	·644	·558	·609	1·644	·793	1

The ammonia solution (·880) should be weighed, not measured. To find weights of other alkalis equivalent to any particular compound, run the finger down the proper column until the figure 1 is reached. The figures in the same horizontal line are the equivalent weights of the other alkalis as denoted at the head of each column. Thus, 1 gr. of carbonate of soda (crystals) equals ·280 grs. caustic soda or ·608 grs. potassium carbonate crystals. A rough and ready method, said to work well in practice when changing from one accelerator to another, is to consider that one drop of liquor ammoniæ is equivalent in its action to 8 gr. of sodium carbonate or 5 grs. of potassium carbonate crystals. Dr. Mason gives the following comparative table:—

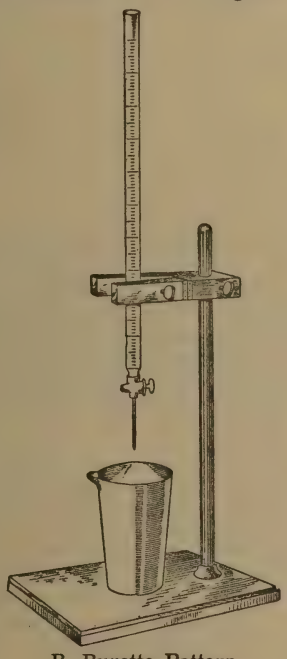
Potassium hydrate	. .	112 grs.
Sodium hydrate	. . .	80 ,,
Potassium carbonate	. .	165 ,,
Sodium carbonate (anhydrous)		106 ,,
Sodium carbonate (crystals)	.	286 ,,
Sodium bicarbonate	. .	168 ,,

(*See also* "Accelerator.")

ALKALIMETER (Fr. *Alcalimètre;* Ger., *Alkalimeter*)

An instrument for testing the amount of alkali present in a commercial sample which may have an admixture of impurities. It was invented by F. A. H. Descroizilles, of Dieppe, though some have claimed the discovery for Dr. Andrew Ure, of Glasgow. It consists of a graduated glass tube divided into 100 degrees

A. Faraday Alkalimeter



B. Burette Pattern Alkalimeter

and furnished at one end with a dropping nozzle. The form recommended by Dr. Faraday is shown at A, but many now prefer to use the more convenient burette pattern B, having a glass tap or pinchcock at its lower end. The tube of the alkalimeter is filled with dilute sulphuric acid, containing as much of the strong acid as would suffice to neutralise a given weight, say 100 grs., of potassium carbonate or sodium carbonate. One hundred grains of the alkali to be tested is then dissolved in water, the solution being placed in a glass beaker or flask, and the acid solution is allowed to drop gradually into it until the mixture is neutralised. The purer the substance the more of the acid will be required. If the tube is emptied to, say, 80 deg., the alkali is known to contain 20 per cent. of impurities. The point at which neutralisation occurs used to be determined by means of litmus or turmeric, but more sensitive and easily recognisable indicators are now employed, the principal of these being methyl-orange and phenol-phthalein. A mixture of these two reagents in alcoholic solution gives a pale yellow colour to a perfectly neutral liquid, which is instantly changed to pink by the least trace of acid, or to a deep red by a trace of alkali. Commercial potassium carbonates and sodium carbonates frequently contain a certain proportion of the sulphate or chloride, silicates, etc., and since the value of the sample depends on the proportion of carbonate present it is obviously requisite to ascertain this. Impure commercial alkalis are, of course, scarcely suitable for photographic purposes, but the above method of testing is often useful. By using an alkaline solution of known strength instead of the acid solution, the strength of acids may be tested; or the strength of a solution of silver may be ascertained by charging the instrument with a standard solution of sodium chloride.

ALKALINE FIXING BATH

A "hypo" (hyposulphite of soda) fixing bath that is not in an acid condition. Fixing baths for printing-out papers should always be distinctly alkaline, and as ordinary mixtures of hyposulphite of soda and water are sometimes slightly acid, various methods of destroying the acidity have been recommended. A normal fixing bath may be rendered alkaline by adding sufficient liquor ammoniæ until after stirring it smells faintly, or by adding sodium carbonate or bicarbonate. A standard formula for an alkaline bath is:—

Hyposulphite of soda	2 oz.	124 g.
Washing soda . .	¼ ,,	16 ,,
Common salt . .	¼ ,,	16 ,,
Water . . .	18 ,,	1,000 ccs.

At least one authority considers this too weak, and reduces the water to 12 oz. or 14 oz. Some advocate the use of ½ oz. of sodium sulphite in place of the ¼ oz. of washing soda. It is not advisable to use this bath with any paper having a substratum tinted pink or mauve, as these colours, which are aniline dyes, would in almost every case be destroyed.

ALLONGÉ PAPER

A rough-grained hand-made drawing paper, used by artists in crayon drawing for process reproduction. It has a very pleasing surface grain, and may be used on the right or wrong side with different results, the right side being the rougher and perhaps the better. This paper may be sensitised for printing a photographic image on to it as a guide to the artist. (*See* "Sensitising.")

ALLYL-SULPHOUREA, ALLYL-THIO-CARBAMIDE, AND ALLYL-THIO-UREA (*See* "Thiosinamine.")

ALPHA PAPERS AND PLATES

A particular make of chloro-bromide printing paper and transparency plate introduced in 1890 and 1891 respectively by Ilford, Ltd. The plate or paper is printed by artificial light, and afterwards developed; the image may then, if desired, be toned in a toning bath, which gives a large variety of colours.

ALTOGRAVURE

A process for the production of half-tone intaglio plates for power-press printing after the style of Rembrandt photogravure.

ALTO-RELIEVO (Fr., *Haut relief;* Ger., *Hochrelief*)

Derived from the Italian term *alto rilievo*, meaning high relief; applied to sculptured, carved, or modelled ornaments and figures which stand out from their background by more than half their proportionate thickness. The term is sometimes employed in processes in which relief is obtained by methods depending on the action of light, the results so produced being known as photo-reliefs. As a rule, however, these processes are not capable of yielding a great amount of relief. A low degree of relief is known as a basso-relievo, or bas-relief (*which see*); while a medium amount is known as a mezzo-relievo.

ALUM (Fr., *Alun;* Ger., *Alaun*)

This term comprises a large class of salts characterised by the formula $M'_2SO_4\ M'''_2(SO_4)_3\ 24H_2O$, in which M′ and M‴ are monatomic and triatomic metals. All the alums crystallise in octahedra, but all do not contain alumina. The following are the principal alums used in photography :—

Ammonia Alum (Fr., *Alun d'ammoniaque;* Ger., *Ammoniakalaun*)

$(NH_4)_2SO_4\ Al_2(SO_4)_3\ 24H_2O$. Molecular weight, 906. Solubilities, 1 in 8·5 water, insoluble in alcohol and ether.

Potash Alum (Fr., *Alun de potasse;* Ger., *Kalialaun*)

Synonym, aluminium and potassium sulphate. $K_2SO_4\ Al_2(SO_4)_3\ 24H_2O$. Molecular weight, 948. Solubilities, 1 in 7·5 water, insoluble in alcohol and ether. This is the most generally used "alum," and is met with in large octahedral clear crystals or a white powder of peculiar astringent taste. It is used for a hardening and clearing bath and for making the "hypo" and alum bromide toning bath.

In process work, potash alum is used with dilute nitric acid for graining or matting the surface of zinc plates previous to coating them with the albumen-bichromate sensitising solution. The graining makes the coating hold better, and after the image has been inked and developed, the grained surface holds the damping solution, which prevents the ink from spreading and soiling the whites when rolling up.

Soda Alum (Fr., *Alun de soude;* Ger., *Natriumalaun*)

Synonyms, sodium alum, sodium and aluminium sulphate. Solubilities, 1 in 2·2 water; insoluble in alcohol and ether. This is occasionally used in place of the ammonia or potash alum.

Chrome Alum (Fr., *Alun de chrome;* Ger., *Chromalaun*)

Synonym, chromium and potassium sulphate, $K_2SO_4\ Cr_2(SO_4)_3\ 24H_2O$. Molecular weight. 916. Solubilities, 1 in 6·25 water, insoluble in alcohol and ether. This is in the form of rich violet coloured crystals, giving a dichroic solution that is reddish violet by transmitted, and green by reflected light, obtained as by-products in the manufacture of alizarine, aniline violet, etc. Stolze suggested the addition of sufficient ammonia to chrome alum solution to give a permanent precipitate after well stirring and then filtering. Namias suggested the admixture of equal quantities of a 10 per cent. solution of ordinary and chrome alums, rendering the mixture alkaline with ammonia, boiling and filtering. Lumière and Seyewetz have also confirmed the statement that alkaline chrome alum exerts a greater hardening effect. The maximum hardening effect is produced by 2 per cent. of the total dry gelatine employed.

Chrome alum is used as an addition to emulsions, and for this purpose it is general to render the solution distinctly alkaline with ammonia, filter, and then render neutral by the addition of glacial acetic or hydrobromic acid. It is also used in the fixing bath (*which see*) and combined bath (*which see*).

Lumière and Seyewetz have pointed out that 100 parts of gelatine are most hardened by 0·64 parts of alumina, and the following table gives the quantities of the aluminium compounds which contain this quantity of alumina :—

Potash alum . . .	6 parts
Ammonia alum . . .	5·6 ,,
Aluminium sulphate . .	4·2 ,,
Aluminium chloride, anhydrous	1·6 ,,
Aluminium nitrate. . .	4·5 ,,

Below these quantities the full hardening effect is not produced, whilst increase produces no greater hardness. They have also pointed out that "alum" has the least hardening effect, and is extremely liable to fungoid growths, so that it is far better to use chrome alum in its place.

In process work, chrome alum is used as a hardening agent for gelatine. It is added sometimes to fish-glue when the image has a tendency to wash away too freely. Also it has been added to the nitric acid bath when etching enamel images on zinc, with the object of preventing the images from being softened.

Iron Alum (Fr., *Alun de fer;* Ger., *Ammoniakeisenalaun*)

Synonyms, ammonia-iron-alum, ammonio-ferric-sulphate, ferric ammonium sulphate. $(NH_4)_2SO_4\ Fe_2(SO_4)_3\ 24H_2O$. Molecular weight, 962. Solubilities, 1 in 2 water, insoluble in alcohol and ether. This is in the form of large pale violet or amethyst octahedral crystals, which give a brown solution when dissolved in tap water, due to the formation of basic iron salts. Used for making ferric oxalate (*which see*).

ALUM BATHS

These are used in both negative and print making. In negative work an alum bath was originally used for the purpose of hardening the film, but with most modern plates and modern improvements in working such treatment is rarely necessary. It serves another purpose, however. If the bath is rendered acid, alum removes all development stain and improves the colour of the negative. A good formula is :—

Common alum . .	1 oz.	58 g.
Hydrochloric acid .	1 drm.	50 ccs.
Water . . .	20 oz.	1,000 ,,

After a short rinsing from the developer, the plate should be immersed in this bath for two or three minutes, then well washed for ten or fifteen minutes, and fixed as usual. The use of a good acid fixing bath renders the employment of an acidified alum bath unnecessary, as it clears and hardens the film while fixing is progressing.

In the carbon and allied processes, in which a bichromate is used for sensitising, an alum bath is employed after the print is developed. Its object is twofold. It hardens those parts of the film that may remain partially soluble, and also removes any yellow bichromate stain that may be left after development. The following is an excellent formula :—

Alum . . .	1 oz.	55 g.
Water . . .	20 ,,	1,000 ccs.

Hot water should be used for dissolving the alum, but the bath must not be used until it is quite cold.

ALUM TROUGH

A glass-sided trough containing alum solution, and sometimes used in the optical lantern between the light and the condenser in order to absorb the heat rays before they reach the slide or other object to be projected. Alum troughs are widely used for cinematograph films, and slides by the screen-plate (colour) processes, as these are easily damaged by heat. Glycerine and other solutions have been advocated in place of a saturated solution of alum, while even plain water, circulating through pipes and a tank on the thermo-syphon principle, is sometimes employed.

ALUM-HYPO TONING

A method of toning black-and-white prints on bromide and gaslight papers to a sepia colour, sometimes referred to as the "boiling process" and as "sulphur toning"; actually it is a sulphur toning process, but not the only one. The formula for the bath is :—

Sodium hyposulphite	2½ oz.	125 g.
Powdered alum .	½ ,,	25 ,,
Granulated sugar .	½ ,,	25 ,,
Boiling water to .	20 ,,	1,000 ccs.

Dissolve the "hypo" in the water first, add the alum slowly, and next the sugar, although this may be omitted if desired. When all is dissolved the solution should be milk white and a sediment should form at the bottom of the bottle, but it should not be filtered. The bath should be heated two or three times to about 120° F. (nearly 49° C.), allowing to cool in between; this "ripening" is necessary because were it omitted the newly-made bath would not work well, and would bleach the prints. The older and more used the bath is (it may be used over and over again) the more evenly it works, and the richer the tones. When possible, one part of an old bath should be added to four parts of the new bath. Another method of ripening the bath is to tear up some old prints and place in the solution previous to heating; still another is to add 5 grs. of silver nitrate to each ounce of the bath, this tending to give a purplish-brown tone. The fixed black-and-white prints to be toned should be placed in the bath when this is cold, and the whole then warmed, keeping the prints on the move. The time of toning will vary according to the kind ot paper and developer, age of print, and temperature of solution. The quickest results are obtained by raising the temperature as high as the picture will stand, generally about 100° F. (nearly 38° C.), but the best tones are those obtained at about 85° F. (between 29° and 30° C.), the average time being fifteen minutes. The bath may be used cold, in which case toning may take as long as two or three days. Prints developed with amidol appear to tone the quickest, and those toned with hydroquinone the slowest. When the prints reach the desired tone they are allowed to remain in the solution until it is tepid, or cold, and then well washed.

Another method of toning with this bath is to harden the prints first of all in a solution of alum (alum 1 oz.; water 30 oz.), or a portion of the cold toning bath, and then place in the alum-hypo bath made hot, and, after toning, in the alum-and-water solution again, finally washing. The object of the alum baths is to prevent blisters, which would in all probability occur if the prints were put direct into the hot toning bath, and thence into cold water for washing. The use of the extra alum baths is obviated by warming the toner containing the prints. Rich and good tones depend upon the print having been properly developed, and upon the ripeness of the bath. If the toned prints are washed for about one hour they may be considered quite permanent, the image consisting of silver sulphide.

The alum-hypo bath may also be used for toning P.O.P. prints. The prints must first be washed, fixed in an ordinary "hypo" bath, next placed in a cold alum-hypo bath, where they tone to a good purple-brown colour, and then washed well. P.O.P. prints to undergo this treatment should be over-printed, since they reduce considerably in toning.

ALUMINIUM, OR ALUMINUM (Fr. and Ger., *Aluminium*)

Al. Atomic weight, 27. A very light, silvery-white metal, obtained by electrolysis from aluminium chloride. It is principally used for the construction of light cameras and for lens fittings, but difficulties in working it and its softness led to the introduction of a harder alloy of aluminium and magnesium, called magnalium. Aluminium is used in some flashlight powders, and in algraphy (*which see*). "Aluminum" is now the accepted American spelling.

Aluminium plates are now largely used for lithography as a substitute for lithographic stone. (*See* "Algraphy.")

In process work, aluminium has been used for relief etching, but is not commercially in vogue. Nitric acid has little action on it, but hydrochloric acid attacks it more readily. Phosphoric and fluo-silicic acids are active mordants, but not convenient to use. Perchloride of iron has a strong action upon it; a solution of common salt will also attack it freely. Aluminium is largely used for the screen and plate holders of process cameras, as it is not readily acted on by the silver nitrate solution.

ALUMINIUM CHLORIDE (Fr., *Chlorure d'alumine ;* Ger., *Chloraluminium*)

Al_2Cl_6 12 H_2O. Atomic weight, 483. Soluble in water, alcohol, and ether. It is a yellowish-white granular crystalline powder which (very rarely) is used in the gold and platinum toning baths. It is extremely deliquescent, and must be kept in well-stoppered bottles.

ALUMINIUM FLASHLIGHT

Aluminium bronze powder, also known as "silver bronze," may be used in place of, or in conjunction with, magnesium for flashlight work. It is cheaper than magnesium, burns under certain conditions with less smoke, but it is not quite so actinic. The first experiments with this metal appear to have been carried out by Dr. Piffard, of New York, in 1888. Dr. Miethe has found that fine aluminium bronze powder (5 to 10 per cent. of aluminium and 90 to 95 per cent. of copper) burns almost completely in the flame of a Bunsen burner. Aluminium, however, is better, even if more dangerous, when mixed with potassium chlorate, in which form it becomes an explosive mixture, and must be treated as such; that is to say, the mixture must have a light applied to it, and not be blown through a flame. The potassium chlorate intended for mixing with the aluminium bronze powder should be quite free from the deliquescent potassium chloride, because if this is present the chlorate will tend to be moist. The chlorate should be well dried, and powdered sufficiently finely as to pass through a sieve of eighty meshes to the inch. The aluminium and the chlorate must not be mixed together in a mortar, but with a feather or a flat blade on a sheet of paper. A suitable formula is :—

Aluminium . . .	1	part.
Potassium chlorate . .	2¼	parts.

For more rapid flashes, antimony sulphide should be added, the formula being :—

Antimony sulphide . .	3	parts.
Aluminium . . .	5	,,
Potassium chlorate . .	15	,,

Another formula is :—

Aluminium . . .	20	parts.
Lycopodium . . .	5	,,
Ammonia nitrate . .	1	part.

All these mixtures are explosive and dangerous, and proper precautions should be observed, as directed under the heading "Flashlight Mixtures," where a formula for aluminium in conjunction with magnesium will be found.

A flashlight mixture, patented in 1904 by Dr. G. Krebs, gives very little smoke and consists of aluminium 2 parts, magnesium 2 parts, and chrome alum 10 parts. A "time" powder, also due to Dr. Krebs, contains aluminium 20 parts, magnesium 80 parts, chrome alum or copper sulphate 100 parts, lime oxide, carbonate, or glass 20 parts. Aluminium cartridges, to contain a flash mixture and burn with it, have lately been made, the metal case being of from ·1 to ·3 mm. thickness.

Aluminiun leaf burned in oxygen gives a very powerful light. The method is to place a few leaves of aluminium in a dry bottle containing oxygen gas, and on applying a lighted taper to the top leaf the contents of the bottle burn with a flash which, for actinic power and general brightness, is said to exceed anything obtainable with an equal amount of magnesium.

ALUMINIUM POTASSIUM SULPHATE (*See* "Alum.")

ALUMINIUM SULPHATE (Fr., *Sulfate d'alumine ;* Ger., *Aluminiumsulfat*)

$Al_2(SO_4)_3$ 18 H_2O. Molecular weight, 166. Solubility, 1 in 2 water. White crystals with sweet, astringent taste, obtained by dissolving aluminum hydrate in sulphuric acid. It has been suggested as a hardening agent, but has found very little use.

ALUMINIUM SULPHOCYANIDE (Fr., *Sulfocyanure d'alumine ;* Ger., *Aluminiumrhodanid*)

Synonym, aluminium sulphocyanate or rhodanide. $Al_2(CNS)_6$. Molecular weight, 402. A yellowish powder occasionally used as a preliminary bath for self-toning papers. It is extremely deliquescent, and must be kept in well-stoppered bottles.

ALUMINOGRAPHY (*See* "Algraphy.")

AMACRATIC

A term relating to photographic lenses and implying that the chemical rays of light are united into one focus. "Amasthenic" is a term with the same meaning.

AMASTHENIC (*See* "Amacratic.")

AMATEUR PHOTOGRAPHER

One who practises photography as a pastime, and not as a profession. In photography the question of who is and who is not an amateur is a difficult one to decide. So-called amateurs do not hesitate to accept a little payment for their prints "just to cover the cost of materials," while others win prizes in cash competitions, or sell prints to periodicals. It is maintained in many quarters that the acceptance of money by an amateur for his work places him in the professional category. The consensus of opinion, however, is that a photographer who does not advertise, invite custom, or rely upon the art as a livelihood, is an amateur. The old controversy and jealousy between amateurs and professionals has, at any rate in Great Britain, faded away to extinction, and the two classes of photographers understand more clearly that their interests are parallel and do not clash, and that photographic progress has need of them both.

AMBER (Fr., *Ambre jaune ;* Ger., *Bernstein*)

A fossil, yellow and translucent resin used occasionally in varnishes, for which purposes it must first be fused.

Fused amber . .	3 oz.	150 g.
Chloroform to . .	20 ,,	1,000 ccs.

When dissolved, filter and use cold.

Another formula is that known as Brannt's, namely :—

Fused amber . .	4 oz.	400 g.
Sandarac . . .	6 ,,	600 ,,
Elemi	1 ,,	100 ,,
Methylated spirit (90%) .	12 ,,	1,000 ccs.

When dissolved add—

Camphor . . .	½ oz.	12½ g.

AMBROTYPES

The American name for wet collodion positives upon glass or "tin" (thin plates of enamelled iron or steel). Those upon glass are sometimes said to be by the "alabastrine process" (*which see*); those upon "tin" are called "tintypes" or "ferrotypes." Ambrotypes are produced by the "finished while you wait" process formerly so extensively practised by itinerant photographers, but now practically superseded. Full particulars will be found under the heading "Ferrotype Process."

AMIDINE (Fr., *Amidon;* Ger., *Amidin*)

Synonyms, amadine, amylum. An amylaceous substance identical in chemical composition with cellulose, and found in many cereals and vegetables. It is practically equivalent to starch. It forms the translucent jelly or paste obtained when boiling water is poured on ordinary starch, so extensively used as a photographic mountant.

AMIDO-ACETIC ACID (Fr., *Glycocoll;* Ger., *Amidoessigsäure, Glykokoll*)

Synonyms, glycocoll, amido-glycollic acid, amino-acetic acid, glycocine, sugar of gelatine. NH_2 CH_2 COOH. Molecular weight, 75. Soluble in water. White crystals, formed by replacing one of the hydrogen atoms of ammonia by the acetic acid. It possesses both acid and basic properties, and the sodium salt NH_2 CH_2 COONa was introduced (1902) under the name of *Pinakolsalz N* by Meister, Lucius and Brüning as a substitute for the alkalis in developers, but on account of its high price did not replace them in practice.

Amido-acetic acid is called sugar of gelatine on account of its sweet taste, and from its being a product of the decomposition of gelatine by acids or alkalis. It is sometimes termed glycin, but must not be confused with the developer of that name (*which see*), this being a phenol derivative of it, having the formula C_6H_4OH NH (CH_2COOH).

AMIDO-BENZINE (*See* "Aniline.")

AMIDO-CARBOXYLIC ACIDS (*See* "Carboxylic Acids.")

AMIDO-GLYCOLLIC ACID (*See* "Amido-acetic Acid.")

AMIDO-PHENOL (*See* "Amidol.")

AMIDOL, OR DIAMIDOPHENOL (Fr. and Ger., *Amidol*)

A developer having the formula C_6H_3 $OH(NH_2)_2$, and introduced in the year 1892. It is sold in the form of a white or greyish crystalline powder, which keeps well in a dry state but in solution rapidly loses its developing powers. The dry amidol is therefore best added to the solution immediately before use. It forms a developer when mixed with a solution of sodium sulphite, no alkali being needed, and it works very rapidly, the detail appearing almost immediately the developer is applied to the plate. This sudden appearance is apt to deceive those unacquainted with it, but the negative must not be taken from the developer until it has attained the required density. It has been stated that amidol will develop when in an acid condition, and appropriate formulæ have been published, but it is better to regard amidol as an alkaline developer, because, even if it does work when slightly acid, it works better when slightly alkaline. The addition of acetone sulphite in quantity equal to that of the amidol preserves the developer for a considerable time, but acts as a restrainer; other preservatives have been advocated, but it is better to add the dry amidol when required for use. A normal developer consists of :—

Sodium sulphite .	600 grs.	60 g.
Amidol . . .	40–60 ,,	4–6 ,,
Water to . . .	20 oz.	1,000 ccs.

The mixed developer will keep well for four or five days. It should be made up with a new solution of fresh and pure sulphite. It is usual to make up a stock solution of sodium sulphite and to add 2 to 3 grs. of dry amidol to each ounce of solution.

Potassium bromide has but little restraining effect in an amidol developer, except when used in large quantities, but when added in small quantities it has a clearing effect. In cases of over-exposure, about 15 drops of a 10 per cent. solution of potassium bromide may be added for every ounce of developing solution. Acetic, citric, and tartaric acids have been recommended as restrainers and sodium hyposulphite ("hypo") as an accelerator, but with the latter the image loses density beyond a certain point. Two- and three-solution amidol developers are rarely resorted to, as they have but little advantage over the one-solution, which is in wide use, particularly for bromide paper, for which most paper-makers give a special formula. The two-solution form is not given here because it is of doubtful value.

Amidol has the property of staining the finger-nails. Sometimes it stains bromide prints a rosy pink colour, which may be removed by the use of eau-de-javelle followed by citric acid.

Another formula with bromide, and specially recommended by Abney for the development of "instantaneously" exposed plates, is :—

Amidol	5 grs.	5 g.
Sodium sulphite .	40 ,,	40 ,,
Potass. bromide .	1 ,,	1 ,,
Water to . . .	2 oz.	1,000 ccs.

This solution will keep for a few days, but is most energetic when fresh.

Another form of a one-solution amidol developer is that known as Balagny's acid-amidol, which has found great favour upon the Continent, both for negatives and bromide paper.

One of its advantages is its slowness. The original formula is :—

Water . . .	10½ oz.	300 ccs.
Amidol . .	30 grs.	2 g.
Sodium sulphite crystals . .	120 „	8 „
Potassium bromide solution (10 %) .	170 mins.	10 ccs.
Sodium bisulphite solution . .	340 „	20 „

The bisulphite solution is a commercial article. A substitute can be made by preparing a saturated solution of the commercial bisulphite and then adding 1 drm. of strong sulphuric acid to each ½ pint. Many similar acid-amidol mixtures have been advocated.

It has been frequently stated that amidol-developed negatives and prints should not be fixed in an acid fixing bath, because of its causing fogging or further development during fixation, but T. H. Greenhall says that there is nothing to be feared in this respect when using bromide paper. An old acid fixing bath heavily charged with amidol and sulphite gave stronger prints than plain "hypo," due to the fact that plain "hypo" had a slight reducing action, and not to any defect in the acid fixer, which was absolutely necessary for some papers.

Some photographers find that amidol has an effect upon the skin resembling that of metol, but not so intense.

AMMONIA (Fr., *Ammoniaque ;* Ger., *Ammoniak, Ammoniakwasser, Salmiakgeist*)

A volatile, pungent gas, which for photographic and many other purposes is used in the form of a watery solution (NH_3OH); formerly known as "spirit of hartshorn." The strongest solution, and that mostly used, is of ·880 sp. g., contains 35 per cent. of the gas NH_3, and is commonly known as "ammonia ·880" or "liq. ammon. fort." "Liquid ammonia" is the incorrect, popular form of the term "liquor ammoniæ." A weaker liquor, kept by most chemists, one-third the strength of the ·880 solution, is rarely used in photography. Ammonia has many uses in photography, the principal being as an accelerator in the pyro developer, for blackening the mercury-bleached image in intensification, in emulsion-making, and as an addition to the bichromate bath for sensitising carbon tissue. Liquor ammoniæ should be kept in a glass-stoppered bottle, as it loses its strength rapidly if exposed to the air, and cork stoppers very soon deteriorate. The fumes of ammonia are extremely irritating to the eyes, throat, and nose, and particular care should be taken when opening bottles of it in hot weather, or when the bottles have been left on a warm shelf, as the liquid may spurt out and cause serious damage. Bottles containing liquor ammoniæ should be kept in a cool place, as heat develops great pressure, which may blow out the stopper or burst the bottle.

A. Haddon states that experiments show that ammonia expands on dilution with water about 18 per cent., and points out how very unreliable and varying is a solution of ammonia in hot weather, freshly bought samples of the ·880 solution varying in specific gravity from that to ·904, or from 35·8 to 26·9 NH_3 per cent. volume. It is this variation that makes it unreliable as an accelerator in development; hence the necessity of using it fresh or keeping it in a gas-tight bottle and in the cool.

In process work, ammonia is not largely used. It is added to the albumen bichromate solution and also to the fish-glue solution to neutralise acidity, and increase the keeping qualities. A few drops added to the developing water makes the albumen bichromate image develop more quickly. A dilute solution of ammonia with whiting is used for cleaning copper, to free the surface from grease. Perchloride of iron solution for etching, especially for photogravure, is often neutralised by the addition of ammonia. Added to copper sulphate until a bright blue solution is formed, ammonia makes a bath for coating zinc with a film of copper without the use of an electric battery.

AMMONIA FUMING

Years ago, when most photographers, both professional and amateur, prepared their own plain salted and albumenised papers, it was customary to expose these to the fumes of ammonia in a box. The ammonia, uniting with the free silver nitrate in the paper, gave greater sensitiveness and richer prints. It has now fallen into almost entire disuse, but it formerly found favour owing to the brilliance imparted to the prints so treated.

AMMONIA METER

A small glass bulb, devised by Haddon and Grundy, which floated at exact balance in a 2·9 per cent. solution of ammonia of a certain temperature, thus enabling the strength to be determined without analysis. It has also been known as a "specific gravity ball."

AMMONIA-IRON-ALUM (*See* "Alum.")

AMMONIA, ROCK (*See* "Ammonium Carbonate.")

AMMONIO-CITRATE OF IRON (*See* "Ferric Ammonio-citrate.")

AMMONIO-NITRATE PROCESS (*See* "Emulsion.")

AMMONIO-OXALATE OF IRON (*See* "Ferric Ammonio-oxalate.")

AMMONIUM (*See* "Ammonia.")

AMMONIUM ALUMINIUM SULPHATE (*See* "Alum.")

AMMONIUM BICHROMATE (Fr., *Bichromate d'ammoniaque ;* Ger., *Ammoniumdichromat; Saures chromsaures ammon*)

$(NH_4)_2Cr_2O_7$. Molecular weight, 252. Solubilities, 1 in 4 water, soluble in alcohol; known also as ammonium dichromate. Orange crystals, obtained by neutralising chromic acid with ammonia. It is sometimes used for sensitising carbon tissue, gum bichromate, and in some photo-mechanical processes, as it has a stronger

sensitising power, and is more soluble than the potassium salt, and in carbon printing gives richer pictures.

In process work, ammonium bichromate is largely used as a sensitiser with fish-glue for printing half-tone images on zinc and copper. It is believed to be a better sensitiser than potassium bichromate in this respect, the latter being chiefly used with albumen for the line process. It gives a more sensitive solution with fish-glue, the solution keeps better, and develops more freely. Ammonium bichromate is said to be more than twice as sensitive to light as potassium bichromate.

AMMONIUM BROMIDE (Fr., *Bromure d'ammonium;* Ger., *Bromammonium*)

NH_4Br. Molecular weight, 98. Solubilities, 1 in 1·4 water, 1 in 31 absolute alcohol. A white, crystalline, slightly hygroscopic powder, with pungent saline taste, obtained by neutralising hydrobromic acid with ammonia, evaporating the solution and crystallising. It is sometimes used as a restrainer in place of the potassium salt, but must not be used with the caustic alkalis or carbonates, as ammonia is set free, which may give rise to fog. Its principal use is in emulsion making. If the salt has become damp by absorption of aqueous vapour, it may be dried in an oven without injury.

AMMONIUM CARBONATE (Fr., *Carbonate d'ammoniaque;* Ger., *Kohlensaures ammon, Ammoniumkarbonat*)

Synonyms, hartshorn, rock ammonia. $(NH_4)HCO_3$ $(NH_4)NH_2CO_2$. Molecular weight, 157. Solubility, 1 in 4 water. Keep in well-stoppered bottle, and before use scrape off any adherent white powder. White, hard, translucent, striated masses, obtained by heating ammonia salts and chalk. It is used in place of liquor ammoniæ in some developers. Hot water must not be used to dissolve it.

AMMONIUM CHLORIDE (Fr., *Chlorure d'ammoniaque;* Ger., *Chlorammonium*)

Synonyms, sal-ammoniac, muriate or hydrochlorate of ammonia. NH_4Cl. Molecular weight, 53·5. Solubilities, 1 in 3 water, 1 in 8 alcohol. A white, crystalline powder, or tough, transparent, fibrous masses, the latter usually known as sal-ammoniac. The pure powdered salt is apt to attract aqueous vapour from the air, whilst sal-ammoniac remains dry. It is chiefly used for salting albumenised paper and also in preparing chloride emulsions.

AMMONIUM CITRATE (Fr., *Citrate d'ammoniaque;* Ger., *Ammoniumcitrat*)

$(NH_4)_3C_6H_5O_7$. Molecular weight, 243. Solubility, 1 in 0·5 water, soluble in alcohol. This salt is so deliquescent and so easy to make that the user should prepare it himself :—

Citric acid . .	1 oz.	100 g.
Distilled water .	2 ,,	200 ccs.

When dissolved add—

Liq.ammoniæ ·880, (about) 250 mins. 50 ccs.

The ammonia should be cautiously added, and the solution tested for neutrality with litmus paper. When neutral, make the total bulk up to 10 oz. or 1,000 ccs. with distilled water, which practically gives a 10 per cent. solution. It is used as a restrainer with the pyro developer in the proportion 5 to 10 grs. per ounce.

AMMONIUM FLUORIDE (Fr., *Fluorure d'ammonium;* Ger., *Fluorammon*)

NH_4F. Molecular weight, 36. Soluble in water and alcohol. This is in the form of small, deliquescent, colourless, flat crystals, and it is used for etching glass and stripping negatives. As it attacks glass, it must be kept in indiarubber or wax-lined bottles.

AMMONIUM HYDRATE

A very seldom used synonym for liquor ammoniæ, NH_3HO.

AMMONIUM HYDROSULPHIDE (*See* "Ammonium Sulphydrate.")

AMMONIUM HYPOSULPHITE (Fr., *Hyposulphite d'ammoniaque;* Ger., *Ammonthiosulfat*)

Synonym, ammonium thiosulphate. $(NH_4)_2S_2O_3$. Molecular weight, 148. Very soluble in water. It occurs in colourless crystals, or can be readily made in solution, as follows :—

Sodium hyposulphite .	5 oz.	248 g.
Ammonium chloride .	2¼ ,,	106 ,,
Distilled water to .	20 ,,	1,000 ccs.

It was suggested first in 1888 by John Spiller as a substitute for the sodium salt, on account of its greater solubility, and therefore of the greater ease with which it can be washed out of prints and negatives. It has recently been patented as a fixing salt. Lumière and Seyewetz point out that fixation is only quicker when the proportion of thiosulphate is less than 40 per cent., and if the proportion of chloride is only sufficient to convert one-fourth of the sodium salt, and further that the use of this salt must be regarded with suspicion on account of the rapid decomposition of the silver salts formed if the subsequent washing is not very rapid.

AMMONIUM IODIDE (Fr., *Iodure d'ammonium;* Ger., *Iodammon*)

NH_4I. Molecular weight, 145. Solubilities, 1 in 0·6 water, 1 in 9 alcohol, slightly soluble in ether. It is a white to yellowish-white hygroscopic crystalline powder, which is very unstable, readily giving off iodine, which may be dissolved out by ether. It is occasionally used in making iodised collodion and negative gelatine emulsions.

In process work, ammonium iodide is a constituent in most iodising formulæ.

AMMONIUM MOLYBDATE (Fr., *Molybdate d'ammoniaque;* Ger., *Molybdānsaures ammonium*)

$(NH_4)_6Mo_7O_{24}4H_2O$. Molecular weight, 1,236. Soluble in water. It is in the form of large colourless or slightly greenish crystals, readily decomposed by heat. It has been suggested as an ingredient in printing out emulsions in order to obtain greater contrast.

AMMONIUM NITRATE (Fr., *Azotate d'ammonium;* Ger., *Salpetersaures ammon*)

NH_4NO_3. Molecular weight, 80. Solubilities, 1 in 0·5 water, 1 in 2·25 alcohol. These colourless, long, rhombic crystals are obtained by neutralising ammonia or ammonium carbonate with nitric acid. It has been suggested as a substitute for the potassium salt in flashlight mixtures (*which see*), though its hygroscopic nature is somewhat against it. It is also formed in emulsion making by double decomposition between ammonium bromide and silver nitrate, and is removed in washing. It is deliquescent, and should be kept in well-stoppered bottles.

AMMONIUM OXALATE (Fr., *Oxalate d'ammoniaque;* Ger., *Ammonoxalat*)

$(NH_4)_2C_2O_4H_2O$. Molecular weight, 142. Solubilities, 1 in 25 water. It is in the form of colourless crystals, obtained by neutralising oxalic acid with ammonia, and it is used to prepare ferric ammonio-oxalate.

AMMONIUM PERSULPHATE (Fr., *Persulfate d'ammoniaque;* Ger., *Ueberschwefelsaures ammonium*)

$(NH_4)_2S_2O_8$. Molecular weight, 228. Solubility, 1 in 2·5 water. It takes the form of colourless crystals, which are obtained by electrolysis. It is principally used as a reducer, and is especially valuable in that it reduces the high lights more than the shadows. The following formula may be used :—

Ammonium persulphate	480 grs.	50 g.
Distilled water to	20 oz.	1,000 ccs.

The negative should be immersed in this until the reduction is nearly complete, and then rapidly washed. A stop bath of sodium sulphite (5 per cent. solution) is sometimes recommended, but it occasionally gives rise to stains, and it is better to use water only. The chemical action which takes place is supposed to be—

$$\underset{\text{Silver}}{Ag} + \underset{\text{Persulphate}}{(NH_4)_2S_2O_8} = \underset{\text{Ammonium sulphate}}{(NH_4)_2SO_4} + \underset{\text{Silver sulphate}}{Ag_2SO_4}$$

The silver sulphate dissolves in water. Namias states that a solution of persulphate acidified with nitric acid acts like the ordinary "hypo" and ferricyanide reducer.

The addition of 0·5 to 1 per cent. to the normal platinotype developer shortens the scale of gradation, and is thus useful for over-exposed prints.

H. W. Bennett has made a special study of ammonium persulphate as a reducer, and his special formula will be found under the heading, "Bennett's Reducer." The addition of ammonium sulphocyanide has been recommended, this causing the persulphate reducer to act in the opposite way—namely, to clear the shadows first after the manner of the ferricyanide and "hypo" reducer, which makes it particularly suitable for negatives of line subjects. The formula for the persulphate reducer often referred to as "Puddy's reducer" is: water 1 oz., ammonium persulphate 25 grs., and ammonium sulphocyanide (10 per cent. solution) 120 minims. Namias advocates a 5 per cent. solution of persulphate made acid with 1 per cent. of sulphuric acid for developing over-exposed carbon prints. Ammonium persulphate has also been suggested as a "hypo" eliminator, stain remover, and as an addition to the oxalate developer for platinotypes; ½ to 1 per cent. added to the normal oxalate developer shortens the scale of gradation and saves over-exposed prints.

AMMONIUM PHOSPHATE (Fr., *Phosphate d'ammonium;* Ger., *Ammonphosphat, Phosphorsäures ammoniak*)

Synonyms, hydrogen diammonium phosphate, diammonium orthophosphate, dibasic phosphate of ammonia. $(NH_4)_2HPO_4$. Molecular weight, 132. Solubility, 1 in 4 water. Sometimes used in emulsion making and in toning, but infrequently; its chief use is in fireproofing fabrics. It is obtained on drying the normal, or neutral ammonium phosphate $(NH_4)_3PO_4$. The latter is made by mixing phosphoric acid and ammonia in concentrated solution; on cooling, the normal salt crystallises out in short prismatic needles.

AMMONIUM AND POTASSIUM CHROMATE (*Fr., Chromate d'ammonium et potasse;* Ger., *Kaliammoniumchromat*)

$NH_4KCrO_4H_2O$. Molecular weight, 191. Soluble in water. The pure salt occurs in bright, yellow crystals, but is rarely used except in the form of a solution which is made by adding ammonia to potassium bichromate solution. It has been suggested as an improved sensitiser for carbon printing, etc., but it frequently makes the tissue horny and reticulated.

In process work, when making up this bichromate sensitising solution for carbon printing, collotype, photo-lithography, and zinc printing, it is usual to add liquor ammoniæ drop by drop until the solution turns a light lemon yellow, and distinctly smells of ammonia. This forms the double chromate of potassium and ammonium.

AMMONIUM SULPHIDE (Fr., *Sulfure d'ammonium;* Ger., *Schwefel-ammonium*)

A yellowish solution, formula $(NH_4)_2S$, having a most objectionable smell; known also as sulphuret of ammonia. It is widely used for toning bromides to a brown colour after bleaching, also for toning P.O.P. Its evil odour and bad-keeping qualities are reasons why some prefer to make it as required, according to the following method: A. Sodium sulphide, ½ oz.; water, 2½ oz. B. Ammonium sulphate, 24 grs.; water, 2¾ oz. Mix A and B, and use at once or any time within ten or twelve weeks; in this form its odour is not so bad. Ammonium sulphide should not be kept in the same room as sensitive plates and papers, as the vapour acts injuriously upon them.

In process work, ammonium sulphide has been extensively used for blackening wet plate negatives after lead or copper intensification, but is now being largely superseded by sodium sulphide.

AMMONIUM SULPHOCYANIDE (Fr., *Sulfocyanure d'ammonium;* Ger., *Rhodanammonium*)

Synonyms, sulphocyanate, thiocyanate, or rhodanide of ammonia. NH_4CNS. Molecular weight, 76. Solubilities, 1 in 0·6 water, very soluble in alcohol. It is very hygroscopic, and should be kept well stoppered. It takes the

form of colourless crystals, obtained from carbon disulphide, strong alcohol, and liquor ammoniæ. It is used in toning printing-out papers. (*See* "Potassium Sulphocyanide.")

A 5 per cent. solution of the sulphocyanide will dissolve gelatine in the cold, and it has therefore been used to develop over-exposed carbon prints.

Owing to the highly deliquescent properties of this salt, it is a common practice to make it up into a nominal 10 per cent. solution as soon as possible after buying. 1 oz. of the salt should be dissolved in 2 oz. or 3 oz. of water, and then made up to a total bulk of 9 oz. Ten drops of this stock solution will then contain 1 gr, so that any toning formula may be made up from it with less trouble than by weighing the damp solid. Two drms. (120 drops) contain 12 grs., which is a good average quantity to mix with 1 gr. of gold chloride and 8 oz. of water.

AMMONIUM SULPHYDRATE (Fr., *Sulphydrate d'ammoniaque;* Ger., *Schwefelammon*)

Synonyms, ammonium hydrosulphide, ammonium sulphide. NH_4HS. Molecular weight, 50. Soluble in water. The pure salt occurs in colourless, crystalline masses, which rapidly turn yellow on exposure to the air. The commercial ammonium sulphide, which is generally used, is prepared by passing sulphuretted hydrogen H_2S into liquor ammoniæ NH_4OH, and forms $(NH_4)_2 S = 68$, a colourless or slightly yellow solution with disagreeable odour. It is used for blackening wet collodion negatives after intensification with silver iodide, copper bromide, or lead nitrate.

AMMONIUM THIOCYANATE (*See* "Ammonium Sulphocyanide.")

AMMONIUM THIOMOLYBDATE (Fr., *Sulfomolybdate d'ammonium;* Ger., *Ammoniak thiomolybdanat*)

$(NH_4)_2MoS_4$. Molecular weight, 260. Solubilities, soluble in water, insoluble in alcohol. It takes the form of red scales obtained by boiling molybdenum trisulphide in ammonium sulphide. Its use has been patented for sulphiding bromide prints in place of sodium sulphide.

AMMONIUM VANADATE (Fr., *Vanadate d'ammoniaque;* Ger., *Vanadinsaures ammoniak*)

Synonym, ammonium metavanadate. $NH_4 VO_3$. Molecular weight, 116. Slightly soluble in water. These colourless crystals have been recommended as an addition to printing-out emulsions to increase contrast.

AMPHITYPE

One of the many curious and interesting printing processes invented by Sir John Herschel, but of no practical value. It depends upon the light-sensitiveness of ferric, mercuric, and lead salts, and it gives a rich, vigorous print which can be viewed from both sides of the paper, or as a transparency. A sheet of paper is prepared with a solution, either of ferro-tartrate or ferro-citrate of protoxide, or peroxide of mercury, and then with a saturated solution of ammonia-citrate of iron. Exposed in a camera for a time varying from half an hour to five or six hours, according to the intensity of the light, a negative is produced on the paper which gradually fades in the dark, but may be restored as a black positive by immersion in a solution of nitrate of mercury, and ironing with a very hot flat-iron.

Amphitype is also the name of a photo-lithographic transfer process invented by W. H. Shawcross, of Liverpool. The paper is sensitised with an iron salt, and keeps indefinitely. It is printed under a negative, then inked all over with a special ink, and developed with a solution of yellow prussiate of potash. The lines of the print are thus covered with transfer ink whilst the ground is a deep blue, which, however, can be bleached away in a solution of common soda. The transfers are applied to zinc or stone in the usual way.

AMPLIFIER

A supplementary lens placed between a positive or image-producing lens and the focusing screen for the purpose of producing an enlarged image. Amplifiers may be positive or negative in their form; if positive, they must be placed outside the principal focus of the primary lens, as in the Dallmeyer photo-heliograph or as in photo-micrography, where the eyepiece (usually of special design) forms the amplifier. When negative amplifiers are used, they may be placed at any point between the back surface of the primary lens and the principal focus; the size of image and the necessary camera extension become greater as the negative lens approaches the positive one. The earliest practical form of negative amplifier was the Barlow lens, designed for shortening the tube length of telescopes. The principle is extensively employed in the construction of the telephoto lens, in which the amplifier is usually termed the "negative element." (*See* "Telephoto Lens" and "Photo-heliograph.")

AMSTUTZ PROCESS (*See* "Acrograph.")

AMYL ACETATE (Fr., *Acétate d'amyle;* Ger., *Amylacetat, Birnenöl*)

Synonyms, essence of jargonelle pears, amyl-acetic ester, isoamylacetate. $C_5H_{11}C_2H_3O_2$. Molecular weight, 130. Solubilities, insoluble in water, miscible in all proportions with alcohol and ether. It is a colourless ethereal liquid with characteristic odour, and is obtained by distillation from amyl alcohol, sulphuric and acetic acids. It is used for making celluloid cold varnish or zaponlack, a formula for which is—

Celluloid . .	150 grs.	15 g.
Amyl acetate to .	20 oz.	1,000 ccs.

This gives a hard, resistant film which can be applied cold to negatives. The addition of acetone gives a milky film. It is also used in the amyl acetate lamp (*which see*).

In process work, amyl acetate is used as a solvent for celluloid, and the resulting varnish is used for stripping instead of collodion. The varnish is used in aerograph retouching for stopping out, and the amyl acetate for removing the varnish after the colour has been applied by the aerograph.

AMYL ACETATE LAMP (Fr., *Lampe à amylacetate ;* Ger., *Hefner Lamp*)

A lamp devised by Hefner-Alteneck and adopted by the International Congress of Photography in 1889 as the standard light for sensitometry. The wick should consist of loose cotton threads, and be held in a tube of 8 mm. (about ·32 in.) internal and 8·3 external diameter, and of 25 mm. (1 in.) length. The height of the flame should be 40 mm. (1·6 in.), and this must be gauged by a sight hole and cross wire. Outside the flame, at a distance of 1 cm. (·4 in.) from its axis, is a metal chimney pierced with a hole 4 mm. (·16 in.) broad and 30 mm. (1·2 in.) long, which can be shifted so as to bring it opposite the brightest part of the flame. The amyl acetate should be free from acetic acid and water, and have a constant boiling point of 138° C. (280·4° F.). The standard English candle = 1·14 H.K. or Hefner-Kerze.

The great objections to the amyl acetate lamp as a standard photographic light are its spectral composition, which is very poor in violet and blue rays, and its variability under varying heights of the flame (1 mm. or ·04 in. variation in height produces an alteration of about 3 per cent.), the influence of aqueous vapour and carbonic acid in the air, and also the state of the barometer on the uniformity of the light. (*See also* " Sensitometry.")

AMYL ALCOHOL (*See* " Alcohol.")

AMYLOTYPE (Fr., *Amylotypie ;* Ger., *Amylotypie*)

A photograph or print obtained by the action of light upon vegetable matter or extracts. (*See* " Anthotype.")

ANACHROMATIC

A name given to certain lenses, mostly of French manufacture, which are uncorrected for chromatic aberration.

ANACLASTIC (Fr., *Anaclastique ;* Ger., *Anaclastisch*)

Capable of refracting, or bending, rays of light. Dioptrics, that branch of optical science dealing with the phenomena of refraction, was formerly called anaclastics.

ANAGLYPH (Fr., *Anaglyphe ;* Ger., *Anaglyph*)

The name given to Du Hauron's stereoscopic pictures. A pair of stereoscopic photographs is taken and half-tone process illustrations prepared from them. The picture belonging to the left eye is printed in one colour — say blue ; and the picture belonging to the right eye is printed in another colour, usually red. The two impressions are superposed, but owing to their stereoscopic dissimilarity they do not exactly register, with the result that a confused effect is produced. To observe the pictures stereoscopically, eyeglasses (*see* " Anaglyphoscope") are provided. If the left eye phase has been printed in blue and the right-eye phase in red, the eyepiece for the left eye will be red, and that for the right eye will be blue. The eye looking through the red glass will observe only the phase that has been printed in the blue colour, and vice versa. The result is that only one picture or stereoscopic phase reaches each eye and the one rightly belonging to it. Further, as both images appear at the same place, unison takes place in virtue of the laws governing binocular perception, and stereoscopic relief is observed. The fundamental principle of Du Hauron's invention has also been applied to lantern stereoscopic pictures.

ANAGLYPHOSCOPE

An appliance or arrangement for the inspection of anaglyphs, usually made in the form of eyeglasses or spectacles with a red and a green glass, or red and blue. Tinted gelatine and other transparent materials are also used. Perhaps the simplest form consists of a card with two circular openings, at a distance apart equal to that between the average pair of eyes, over which are glued pieces of gelatine of the requisite tints. This is simply held up to the eyes in viewing the anaglyph, which is then seen in stereoscopic relief.

ANALYSER (Fr., *Analyseur ;* Ger., *Analysator, Zerstreuungsprisma*)

A prism of Iceland spar, divided diagonally down its long axis, which receives the extraordinary ray from the Nicol prism (*which see*). The analyser enables the observer to study the phenomena of polarised light. It is usually mounted in a brass cell above the objective, but may be placed above or in the eyepiece. (*See also* " Polariscope " and " Polariser.")

ANALYTICAL PORTRAITURE

The taking of several properly adjusted portraits of different persons upon one plate, or the printing of several different portrait negatives upon one piece of paper ; the result is supposed to give the type of the whole. Better known as " Composite Portraiture " (*which see*).

ANAMORPHOSCOPE (Fr., *Anamorphoscope ;* Ger., *Anamorphoskop*)

A cylindrical convex mirror for reflecting the image of a distorted drawing and restoring it to its proper proportions. Concave or convex mirrors distort images in a singular manner, and produce very interesting effects. Anamorphoses constitute particular objects belonging especially to the class of experiments relating to cylindrical mirrors. They are images made according to determined rules, but so distorted that, regarding them fixedly, only confused strokes can be distinguished. When they are seen reflected in the curved mirrors, they present, on the contrary, a perfectly regular appearance. In other words, an anamorphose is a distorted diagram, the corrected image of which can be seen in the mirror of the convex anamorphoscope. It may be said that distorted copies of photographs suitable for inspection in an anamorphoscope may be prepared in the following manner: Procure an optically worked cylindrical concave mirror large enough to reflect a half-plate photograph. Place the photograph in a horizontal position upon a table, and place the mirror at right angles thereto, keeping it vertical. On looking into the mirror from a given position, a distorted image of the photograph will be seen. This image may now be photographed by placing a camera lens

at the point previously occupied by the eye, a position to be discovered by experiment, and which will, of course, depend upon the curvature of the mirror in use and the focal length of the camera lens. The resultant photograph will bear no apparent resemblance to the original; but if viewed in a convex cylindrical mirror whose curvature corresponds to the curvature of the concave mirror, a true copy of the original photograph, in miniature, will be seen. The order of things may be reversed with equally true results. In taking photographs of this character it is important so to arrange the lighting that the original photograph receives full illumination, while the mirror is well shaded.

A curious effect may be produced by taking a photograph with a plate placed very obliquely to the axis of a lens or pinhole, the latter being preferable. The image is of course terribly distorted, but upon being viewed from a position similar to that occupied by the lens it will appear correct. A portrait painted in this style may be seen in the National Portrait Gallery, London.

ANAPLANATIC

Not aplanatic. The term has been applied (incorrectly) to ordinary rectilinear lenses.

ANASCOPE (Fr., *Anascope;* Ger., *Anaskop*)

A focusing glass or optical arrangement by the aid of which the image on the camera screen is seen right way up instead of being inverted.

ANASTATIC PROCESS (Fr., *La Photographie Anastatique;* Ger., *Anastatisch Druck*)

A method of copying line drawings by placing a sensitive material with its film side in contact with the drawings, and exposing to light through the back of the sensitive paper or plate. This process, originally invented by J. H. Player, has been rediscovered and elaborated by E. E. Fournier d'Albe, who has given it the above name. As in Playertype, it depends on the fact that the light passing through the plate or sensitive paper is reflected back to the film from the white surface of the plan or drawing, whereas the dark lines of the latter reflect hardly any light. If plates are used, the photo-mechanical kind is best. The exposure is about the same as would be required to make a positive transparency from an ordinary negative on the same kind of plate. A quick-acting developer giving contrast is to be preferred, as, for example, hydroquinone with caustic potash, or a 1 in 15 solution of rodinal. The slight fog that occurs in the lines may be removed by a brief immersion in a ferricyanide and "hypo" reducer after fixing and washing, following this by at least half an hour's further washing.

A positive instead of a negative may be produced by soaking an unexposed dry-plate for five minutes in a 10 per cent. solution of potassium bichromate and allowing it to dry, of course in non-actinic light. This is exposed to daylight through the glass side, in contact with the drawing to be copied, and is developed with a dilute rodinal solution. The parts which have received reflected light from the drawing are rendered more insoluble than those parts in contact with the darker portions, and the latter in consequence alone absorb the developer. It follows that the lines of the original are developed out, while the background remains white or nearly so. The positive is fixed in "hypo" as usual. Copies can also be produced by this process on bromide paper, and there are many other ways in which the process may be applied. It is immaterial if the drawing has printing or other matter on the back. Distinctive points of this process are that no camera or lens is employed, and that the copy is exactly the same size as the original.

Anastatic photography must not be confused with the anastatic lithography process described below.

ANASTATIC PROCESS OF LITHOGRAPHY

A process of lithography by which prints, particularly old ones, may be treated so as to yield a transfer, which may be inked up and printed from. The essential features of the process are that the ink of the print is softened and made transferable by damping the back of the paper with dilute acid; or the print is so treated that the ink can be reinforced by rolling it up with an ink roller without soiling the paper. The usual method, when the print is not too old, is to wet the print with a weak solution of nitric acid in water. It is then placed face downwards on a sheet of polished zinc and passed through the press. Sometimes the plate is flooded with turpentine, and, after allowing it to stand, the surplus is squeegeed off. Then the print is laid down before the turpentine has had time to evaporate. Another procedure is to float the print face upwards on a solution of 1 part of sulphuric acid in 20 parts of water. When damped through, superfluous moisture is removed between blotting-paper, and the print is then left in contact with the plate for some time.

The following is said to be a process employed by a Paris firm, who make a speciality of lithographic facsimiles of old and rare prints. Prepare a bath as follows:—

Sulphuric acid . . .	3 to 5 parts.
Alcohol	3 to 5 ,,
Water	100 ,,

The proportions are varied according to antiquity of the print, thickness of paper, etc. In this solution soak the print from five to fifteen minutes, remove, spread face downwards on glass, and wash thoroughly in a gentle stream of running water. If the paper is heavy, reverse the sides, and let the water flow over the print as well; remove carefully, and place on a heavy sheet of blotting-paper, cover with a similar piece, and press out every drop of water possible. A wringing machine with rubber rollers is most convenient for the purpose. The print, still moist, is laid face upward on a heavy glass plate, or lithographic stone, and smoothed out. With a very soft sponge go over the surface with a thin gum-arabic solution. The print is now ready for inking, which is done with a lithographic roller and lithographic ink thinned with turpentine. The print is then applied to a zinc plate or a lithographic stone, and as many copies as desired "pulled"—that is, printed by the usual lithographic method.

ANASTIGMAT

A lens free from the defect known as astigmatism (*see* "Astigmatism" and "Lens"). Anastigmatic is the adjective formed from this term.

ANGLE OF FIELD OR OF VIEW

The angle subtended by two lines drawn from the node of emergence of any lens to the corners of the plate in use. As a general rule, when the angle of field of a lens is referred to, the extreme angle which the lens is capable of covering is meant, and it should be clearly stated in all cases whether this angle is measured along the longest side of the plate or diagonally from opposite corners. It will readily be seen that a much wider angle can be included in a circular picture than in a rectangular one if the full diameter of the image circle is taken as the base instead of taking the longest side of the plate. For example, when using a 6-in. lens which will illuminate a 12-in. circle, the extreme angle is 90°, but the largest rectangular picture (say, 9½ in. by 7½ in.) which could be placed within this circle would include an angle of less than 77°. To cover a plate having a base line of 12 in. (12 in. by 10 in.) to the corners, an image circle of 15·6 in. is required, giving an angle of 90° along the longest side of the plate. (*See also* "View-angles, Table of.")

ANGLOL

An English trade name for eikonogen (*which see*).

ANGULAR APERTURE

A synonym for focal aperture (*which see*). It has no relation to the angle embraced by the lens, being a measure of rapidity only. The statement that a lens has a large angular aperture means in simple language that it is very rapid in its action.

ANHYDROUS (Fr., *Anhydre;* Ger., *Wasserfrei*)

A term applied to chemicals when deprived of water; literally, not containing water. Anhydrous sodium sulphite is the most widely used anhydrous salt in photography. It is said to keep better in an anhydrous state than when crystallised. The anhydrous salt is double the strength of the crystallised salt, so that 1 part of the former may at any time be replaced in a formula by 2 parts of the latter, or vice versa. Anhydrous chemicals are not so popular in England as in many other countries.

ANILINE (Fr., *Aniline;* Ger., *Anilin*)

Synonyms, aniline oil, phenylamine, amido-benzene, amido-benzol. $C_6H_5NH_2$. Molecular weight, 93. Solubilities, insoluble in water, miscible in all proportions with alcohol and ether. It is poisonous, the antidotes being the use of the stomach pump and emetics. Its sole use is in the now obsolete aniline process (*which see*), and as the starting-point for the manufacture of numerous artificial colouring matters. It should not be confused with aniline, or coal-tar, colours (*which see*).

ANILINE, OR COAL-TAR, COLOURS

Under this generic name are included all the artificial colouring matters or dyes, some of which are of great interest photographically, either from their sensitising properties or their uses as colour screens or filters. Others, again, are used for tinting prints, transparencies, etc. It would be impossible to give information with regard to all the dyes, but the principal ones are briefly dealt with under their respective names. (*See also* "Orthochromatism," "Filters," "Colour Sensitisers," etc.)

In process work, aniline dyes are extensively used, especially in three-colour reproduction. They are either applied to the plate by bathing, or by adding to the emulsion as in the collodion emulsion process. For the latter they are also sometimes flowed over the plate before exposure. Attempts have also been made to bathe wet collodion plates, but the process has not come into commercial use. Methyl violet is an aniline dye that is largely used for dyeing the fish-glue image in order to make it visible during development. The dyes are also much used for making colour filters, either by staining gelatine and collodion films and allowing them to dry (dry filters), or as aqueous or alcoholic solutions, which are contained in glass cells and placed in front of or behind the lens.

ANILINE PROCESS

A process patented on November 11, 1864, by W. Willis, of Birmingham, for reproducing, without a negative, drawings made on tracing or other transparent paper. It is cheap, and the results are fairly permanent, but it has never come into general use. Paper is prepared with a solution of potassium (or ammonium) bichromate, 30 grs.; dilute phosphoric acid, 60 minims; water, 1 oz.—the paper being brushed over with the mixture. When dry, a print is obtained by exposure to daylight under the drawing on transparent paper. It is then developed by exposure to the fumes of 1 part of aniline dissolved in 16 parts of benzole, sprinkled upon blotting-paper, and placed in a shallow box, the exposed paper being pinned to the inner side of the lid. When fully developed the picture is washed and placed in water acidulated with 1 per cent. of sulphuric acid and again washed. The finished print is of a bluish-black colour. This process is suitable for copying plans, etc., other methods being the "Blue Print Process," "Ferrigallic Process," etc. etc.

ANIMALCULÆ TANK (Fr., *Cuvette des animalcules;* Ger., *Microskopischer Tierchenbehälter*)

A shallow glass-sided tank for use as a slide with the projection microscope and optical lantern, in order to show animalculæ and small water insects on the screen. A good temporary substitute is made by clamping together two strips of glass, with a semicircle or ring of india-rubber between them to form a cell.

ANIMALS, PHOTOGRAPHY OF

This branch of photographic work is one that has received increasing attention as improvements have been made in lenses, plates, apparatus, and special devices. The reflex camera and the telephoto lens, especially, have been effective helps to the natural history photographer. Animal photography may be roughly divided into three

sections: (*a*) that of domestic animals—the horse, cow, sheep, dog, cat, etc.; (*b*) that of wild animals in their natural habitat; (*c*) that of wild animals in captivity.

In the case of wild animals in their native haunts, a very limited amount of work may be done with the ordinary apparatus; still more may be accomplished by the use of telephoto lenses; while a good deal has been done by special arrangements by means of which animals have been made to photograph themselves, so to speak, by flashlight.

The methods of dealing with domestic animals, and with wild animals in captivity, are practically identical. The work is greatly facilitated by the use of a reflex camera; a lens of fairly long focus in relation to the plate, and of large aperture; a rapid plate; and a shutter working as quietly as possible with high efficiency and capable of good speed. It is advisable to know something of the animal to be dealt with, especially its characteristic poses and movements. The reflex camera enables the worker to keep the animal accurately in focus and in position on the plate, and to make the exposure at the most suitable moment. The use of a large stop makes full exposure possible even at high-shutter speeds, and also bestows the important advantage of being able to keep the background diffused while the animal itself is sharply defined.

Selective focusing and a suitable lighting of the animal itself are important factors in obtaining an impressive result. It must be remembered, however, that even when the background is diffused its character and suitability must be carefully considered. If, for example, it contains many points of bright light, these may be exaggerated into "blobs" that are unsightly and irritating. Another thing to avoid is the use of a short focus lens at close quarters, especially when taking an animal "head on," the result being an exaggeration of the head and a dwarfing of the body. It is generally advisable, particularly in the case of small animals, to hold the camera low down. An effort should be made in the case of wild animals in captivity to keep out of the picture any railings, network, or other evidence of their not being in their natural haunts.

When the camera used focuses to scale, and a reflex camera is not available, failure is minimised by not attempting work at very close quarters, but rendering the animal on a smaller scale and afterwards enlarging the result. The most noticeable drawback to this procedure is that the surroundings and background are rendered too sharply, and so compete in importance with the animal itself. (*See also* "Birds, Photography of," and "Zoological Photography.")

ANIMATED PHOTOGRAPHY (*See* "Kinematography.")

ANIMATOGRAPH (*See* "Kinematograph.")

ANIME (*See* "Gums and Resins.")

ANOMALOUS DISPERSION (Fr., *Dispersion irregulière*; Ger., *Abweichende Zerstreuung*)

As a rule, light rays of short wave-length are refracted more than those of long wave-length when passing from one transparent medium to another of different density. With some refracting media, however, this law is departed from to a certain extent. When this occurs it is known as anomalous dispersion.

ANTHION

A trade name for potassium persulphate (*which see*).

ANTHOTYPE

An obsolete "nature printing" process invented by Sir John Herschel and founded upon the sensitiveness of juices of plants. Chevreul and Hunt also experimented in the same direction. The expressed juices, and alcoholic or watery infusions of certain flowers, more particularly *papaver rhœas* and *corchorus japonica*, were spread on paper and printed upon under a negative. Herschel found that the most sensitive colour was the yellow tint of the japonica, and that the blue tincture of the double purple groundsel completely bleached in the sunshine. According to his original instructions, published in 1842, the petals of fresh and well selected flowers are bruised to a pulp in a marble mortar, either alone or with a small quantity of alcohol, and then are squeezed through fine linen. The paper to be treated is moistened at the back with water, by sponging and blotting off, and pinned to a board, moist side downwards. The alcoholic tincture (mixed with a very little water if necessary) is then applied with a brush, in strokes from left to right. Then with a sweeping movement carry the strokes up and down so as to cover the paper completely and leave no spaces. The paper is dried quickly, over a stove or otherwise. Papers so prepared generally require an exposure under a negative of about three or four weeks, and the pictures are not permanent. Herschel found that similar effects could be produced by light on the gums, resins, and residues of essential oils, when thin films were spread on metal plates; also that a paper coated with an alcoholic solution of guaiacum, and placed in an aqueous solution of chlorine, acquired a beautiful blue colour, and could be used for copying engravings. All images by these processes quickly fade, and are of no value except as curiosities while they last. (*See also* "Nature Printing.")

ANTHRAKOTYPE (Fr. and Ger., *Anthrakotypie*)

A dusting-on process, suitable for copying tracings or line drawings, first described by Dr. Sobacchi, and elaborated by Captain G. Pizzighelli. Paper is coated with, say, a 10 per cent. solution of gelatine, and when dry is sensitised in a solution of potassium bichromate of about 5 per cent. strength. After again drying, the paper is exposed under a tracing or other suitable positive until the ground assumes a light brown colour, on which the lines are faintly visible in pale yellow. The print is then soaked in slightly warm water for about two minutes, blotted off, and dusted over with a pigment. The latter may be any finely powdered colour, lampblack being suitable. The pigment adheres to the unexposed parts (that is, the lines of the drawing), which are swelled by the water; while the portions on which light has acted are ren-

dered insoluble, and take only slight traces of the colour. When dry, any of the pigment adhering to the exposed parts is removed carefully with a damp sponge.

ANTHRAPHOTOSCOPE

An incorrect form of the word "anthrophotoscope" (explained below).

ANTHROPHOTOSCOPE (Fr., *Anthrophotoscope ;* Ger., *Anthrophotoskop*)

A kind of photographic peep-show, patented in 1867 by Dr. Isaac Rowell and Francis E. Mills, of San Francisco. Portrait photographs are carefully cut out from their backgrounds and placed in front of substituted backgrounds attached to an inclined plane, diverging upward from the plane of the portrait and intersecting the latter at the feet. By this arrangement the foreground is slightly nearer to the observer than the middle distance, while the distance is still further off, so that when viewed with both eyes through a large magnifying lens of long focus, the illusion of perspective and at least an imitation of stereoscopic relief are obtained. By means of a small toothed wheel the pictures may be arranged into groups at pleasure, and the scenery in the background may also be varied as desired.

ANTI-CURLING FILMS

Rollable or flat films which do not curl during developing and drying. The makers prevent curling by coating the back of the film with gelatine, or other substance, to counteract the curling properties of the gelatine on the sensitive side of the film. Previous to the introduction of the above films, it was customary to soak ordinary films, after developing, fixing, and washing, for a few minutes in a solution of 1 part of glycerine to 40 parts of water, and afterwards to dry. This solution checks curling, but keeps the film slightly moist, and at times leads to stains and fading.

ANTIDOTES (*See* "Poisons and Their Antidotes.")

ANTI-HALATION PLATES

Dry plates coated on the back (plain glass side), or otherwise prepared, to prevent light being reflected to the film when in the camera. Such reflection causes the defect known as halation (*which see*). Dry plates made of green glass instead of white glass are said to prevent halation perfectly (no backing being necessary), but they are not articles of commerce.

The earliest forms of anti-halation plates were made by staining the film. W. E. Debenham, in 1891, used saffron and logwood, but these increased the exposure. Weir Brown advocated dipping plates in ammoniacal erythrosine. A. Haddon suggested a thin coloured substratum, and T. Bolas the coating of ruby glass with emulsion and then stripping the film, also the addition of some neutral salt to the emulsion. Anti-halation plates with a coloured substratum were for a time articles of commerce, but the term now generally refers to plates backed in the ordinary way. (*See also* "Backings, Plate.")

ANTILUMIN

A special paper impregnated with a ruby or orange dye and rendered semi-transparent. It is used for covering dark-room windows and lanterns, to make the light "safe."

ANTIMONY PROCESS (Fr., *Photographie à l'antimoine ;* Ger., *Spiessglas-Druck*)

A printing process discovered by Francis Jones, of the Manchester Grammar School, in 1876. When the gas stibine, or antimonietted hydrogen (SbH_3), is passed through a glass tube containing sulphur, in the presence of sunlight, a decomposition takes place, resulting in the formation of the orange antimony sulphide :—

$$\underset{\text{Stibine}}{2SbH_3} + \underset{\text{Sulphur}}{6S} = \underset{\substack{\text{Antimony}\\\text{Sulphide}}}{Sb_2S_3} + \underset{\substack{\text{Sulphuretted}\\\text{Hydrogen}}}{3H_2S}.$$

Since no change occurs in the dark, it was found possible to utilise the reaction for photographic purposes. Ordinary writing paper may be treated with a solution of sulphur in carbon disulphide and the solvent allowed to evaporate, the loose grains of sulphur being then gently brushed off the surface with a tuft of cotton-wool. A special printing frame is used, having a tube led into the back, so that the gas may be conveyed into the felt with which this is lined in order to impregnate the paper. A fern, a piece of lace, or other suitable object having been placed in the frame and the paper laid over it, the frame is exposed to sunlight, and connection is made with the gas. A print of an orange red colour is quickly produced, the image consisting of permanent metallic sulphide imbedded in free sulphur. No fixing is required, the gas being simply disconnected when printing is sufficiently advanced. The operation should be carried out in the open air, care being taken not to inhale the fumes, which are poisonous. To obtain the gas, a small quantity of a solution of antimony trichloride (butter of antimony) is added to any hydrogen generating apparatus, as, for example, a Woulff's bottle furnished with a thistle funnel and a delivery tube, and containing dilute sulphuric acid and granulated zinc. The emerging gas then consists of a mixture of antimonietted hydrogen and hydrogen. It is advisable to dry the gas by passing it through a calcium chloride tube before leading it into the printing frame. Although of considerable interest, this process appears to have certain disadvantages, which have hitherto prevented its use by the practical worker, not the least of these being that the silver image of a negative begins to be affected by the sulphur after several impressions have been taken.

In process work, there is an antimony process which consists in blackening a zinc plate with a solution of antimony chloride in order that an image transferred to the plate may show up after the plate has been slightly etched. This allows of an artist working on the plate by stopping-out for re-etching.

ANTIMONY SULPHIDE (Fr., *Sulfure d'antimoine ;* Ger., *Schwefelantimon*)

Synonyms, antimonous sulphide, black antimony. Sb_2S_3. Molecular weight, 336. Solubilities, insoluble in water, soluble in hydro-

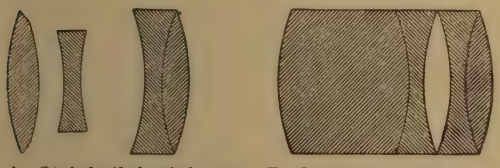
chloric acid. It is poisonous, the antidotes being the use of the stomach pump and emetics. It takes the form of a greyish black powder or steel-grey metallic masses, occurring native. It is occasionally advised as an admixture with magnesium powder for flashlight work, but its use is not to be recommended as the products of its combustion are poisonous.

ANTIPHOTOGENIC (Fr., *Antiphotogénique ;* Ger., *Antiphotogenisch*)

Opposed to photographic or photo-chemical action ; non-actinic.

ANTIPLANAT, OR ANTIPLANATIC LENS

A lens introduced by Steinheil, of Munich, in 1881, and made in two intensities, *f*/3 for portraits A and *f*/6 for general work B. They differed



A. Steinheil Antiplanat F/3 B. Steinheil Antiplanat F/6

from most contemporary lenses inasmuch as they were composed of a positive front and a negative back lens. In the more rapid form the antiplanat may be regarded as a triple combination lens, while in the slower one it is a doublex.

ANTIPYR

An American trade name for formaline.

ANTISEPTICS (Fr., *Antiseptiques ;* Ger., *Fäulnisswidrig Mittel*)

Agents used to prevent putrefaction. They find but very limited use in photography. Thymol or phenol is used for gelatine emulsions, and salicylic acid in one or two aqueous solutions which have a tendency to form fungoid growths.

ANTISPECTROSCOPIC (Fr., *Antipectroscopique ;* Ger., *Antispectroskopisch*)

An optical term applied to a lens to signifiy that it does not split up white light into its constituents. Achromatic (*which see*) has the same meaning.

APERTOMETER (Fr., *Ouverture mètre ;* Ger., *Oeffnungmesser*)

An instrument for measuring the numerical aperture of a lens or objective. Of those forms used in photomicrography, the best was devised by Abbe, consisting of a semicircular glass plate with the various apertures figured on the outer edge. The straight edge of the glass is bevelled to an angle of 45°, and in the centre of the bevel is a metal disc pierced with a small hole. The lamp must be placed opposite and in line with this hole. The objective to be tested is focused on the metal edge of the hole, the draw-tube is removed, and a low-power objective, which forms part of the apparatus, is screwed into the lower end. The draw-tube with this second objective is replaced, and the auxiliary lens is focused by means of the draw-tube upon the back of the objective which is being tested, by sliding the draw-tube up and down till the images of two metal pointers on the outer edge of the apertometer are sharply defined. A band of light should be seen across the field, and the pointers are moved till they just reach the edge of the luminous band, where it disappears from the field of view. The readings given by the outer edges of the metal pointers are added together, and the half of the sum gives the numerical aperture.

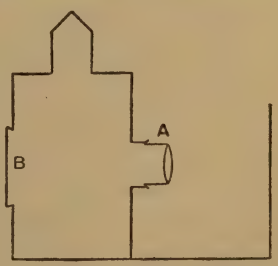
Cheshire's is an inexpensive and fairly accurate apertometer, consisting of a glass disc with concentric rings on the under surface. The objective is focused on a mark in the centre of the plate, and the eyepiece is then removed. The observer looks down the tube and notes the number of rings which are visible on the back lens of the objective. The value of each ring is 0·1 numerical aperture (N.A.), and the total gives the N.A. of the objective.

APERTURE

The diameter of the beam of light admitted by a lens, which may or may not coincide with the diameter of the "stop" or "diaphragm" (*which see*). A lens which can be used with a comparatively large stop, or no stop at all, without showing want of definition or other defects, is said to be "rapid," and to have a "large working aperture." When there is no stop in the lens at all, it is said to work at "open aperture" or "full aperture."

APHENGESCOPE (Fr., *Mégascope, Aphengescope ;* Ger., *Aphengeskop, Wunderkamera für Undurchsichtige*)

In the aphengescope or opaque lantern, also sometimes called the megascope, the images are projected upon the screen by reflection instead of by transmitting the light through transparencies. The first magic lantern of this nature appears to have been invented by Euler, the mathematician, and was described in his "Letters to a German Princess." In his letter to her of

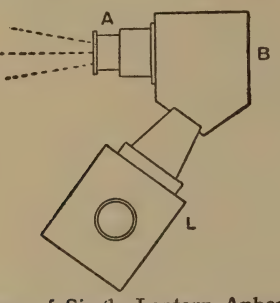


A. Euler's Aphengescope

January 8, 1762, he gives diagram A, and says that he had the honour of presenting her with one of the lanterns six years previously.

The object to be optically projected was placed in the back of the lantern at B, and opposite it in a sliding tube in the front of the lantern was the projection lens A. It contained two side wings, with lamps and mirrors to illuminate the object. In the "Encyclopædia Metropolitane"

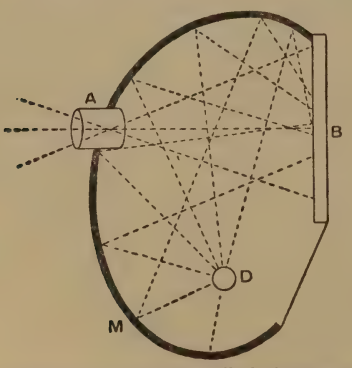
is a plan of this or another lantern by Euler for the projection of opaque objects. Prior to Euler's invention it seems that the rays of the sun were used to illuminate an object the image of which was then thrown upon a screen. Really practical instruments, however, were not constructed until about the year 1839, when Mr. Longbottom used the oxyhydrogen light in



B. Diagram of Single Lantern Aphengescope

conjunction with opaque lanterns, with which he gave exhibitions at the old Polytechnic Institute, London. Twenty years later Mr. Chadburn, of Liverpool, obtained a patent for a lantern of the opaque class, in which he also used oxyhydrogen illumination.

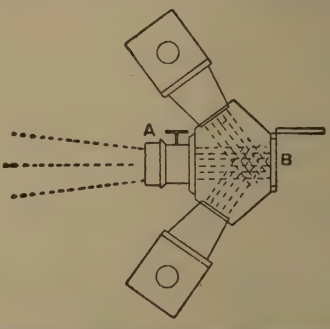
In all aphengescopes great illuminating power is necessary if a large picture upon the screen is desired. Fair results may be secured by using an ordinary optical lantern for the purpose, arranged as shown in B, in which A is the objective lens, L the lantern containing the source of illumination, and B the space in which to place the picture or object to be projected. When very large pictures are needed two lanterns may be



D. Foote's "Polyopticon" Aphengescope

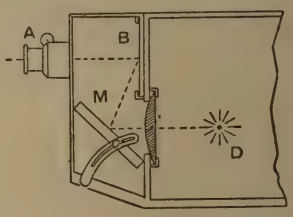
used, as indicated in illustration C. The double source of illumination makes the picture or object B very bright, and the lens A transmits a brilliant image to the screen.

A most ingenious form of aphengescope was invented some years ago by an American, Dr. Foote, of New York, who termed his instrument the "Polyopticon Wonder Camera." Great illumination is secured by the use of a concave mirror M, in illustration D, gathering up all the rays from a lamp at D, and reflecting on to the picture at B; the objective lens is shown at A. The reflector is pierced for the lamp-chimney, and also for the object glass. The apparatus may be compared to a huge egg, having one end sliced off obliquely, against which opening the picture to be projected is placed. There is no condenser needed, and although the size of the projected picture is necessarily of limited dimen-



C. Diagram of Double Lantern Aphengescope

sions, it is very popular in the United States for projecting enlarged views of cartes, coloured lithographs, etc., of small size. Illustration E represents a more recent form of aphengescopic attachment. The objective lens is at A, the object or picture to be projected at B, and a mirror at M, the latter serving to divert the rays coming from the illuminant D from a horizontal into a more or less vertical direction. A biunial form of this apparatus is shown in illustration F. Two lanterns are used, and two mirrors M concentrate the light to a common point B, where the picture or object to be projected is situated. Naturally, a much brighter picture is the result, and accordingly a much larger image upon the screen is permissible. The aphengescope suggested by Mon. Trouvé, and introduced by Mon. Molteni, of Paris, was termed "l'Auxanoscope," and the



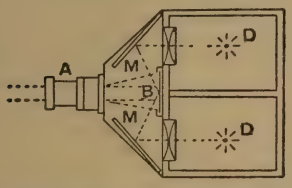
E. Recent Type of Aphengescope with Adjustable Diverting Mirror

simplest form of this apparatus is provided with a lamp on each side of the objective. The incandescent electric lights are fixed in tubes, the ends of which are provided with reflectors, with a hole in each to allow of the insertion of the conducting wires. In the pattern having three illuminants, two are used as just described; while a third, at the back, is utilised for transmitting light direct when inserting an ordinary transparency in the groove provided.

Devices on the same principle have lately been used for projecting the image of the dial of a watch upon the ceiling so that a person lying in bed may switch on the lamp and see the time.

A practicable form of aphengescope for attachment to optical lanterns is hexagonal in plan, and is made of either wood or metal. At the back are two doors permitting of one object being shown while another is being prepared. At the front are three holes, the central one having a flange to receive a lantern objective of long focus and large diameter, and the side holes being bushed with brass tubing to receive the draw-tubes of two lanterns. The object to be shown is placed in the aphengescope behind the objective.

Modern lighting facilities are responsible for the recent revival in opaque lanterns. Incandescent gas, incandescent electric lamps, and the more powerful electric arc, supply all that is necessary with regard to illumination in order



F. Biunial Form of Aphengescope

to procure brilliancy of image upon the screen. But with improved lighting facilities comes the possible evil of overheating the subject, and consequently damaging the originals. One precaution against this evil suggests itself in the form of an alum tank, interposed between illuminant and subject, which performs the function of absorbing heat rays without unduly interfering with the course of the illuminant rays. Such a device has often been used in conjunction with lanterns when projecting transparencies, especially when the slide is required to remain stationary for any length of time. Moving panoramic pictures for the aphengescope have been suggested, and in this case it may not be necessary to introduce an alum tank or heat absorber; but for lecture purposes, when the picture is fixed for a considerable period, an absorber is a useful adjunct.

"Mirroscope" is the name given to a recent form of aphengescope, and it is designed separately for electric, acetylene, and incandescent gas light.

APLANAT

A lens sufficiently well corrected for chromatic and spherical aberrations to define well at a large aperture. The name is now usually applied to lenses of the rapid rectilinear type, although a special lens called a "rapid aplanat" ($f/6{\cdot}5$) was introduced by Steinheil in 1893. This somewhat resembled the antiplanat of the same maker in having a positive front and negative back lens, but consisted of five glasses.

APLANATIC

Capable of working at full aperture, a term first applied to photographic lenses by Thomas Grubb, of Dublin, who introduced an "aplanatic landscape lens."

APLANATISM

The quality of being aplanatic.

APOCHROMATIC (Fr., *Apochromatique;* Ger., *Apochromatisch*)

A term applied to lenses in which light of more than two colours is brought to a focus. In the ordinary achromatic construction, the green and yellow rays near the D line in the spectrum and the violet-blue rays near G are combined; but in the apochromatic lenses the red rays also come to a focus on the same plane. This quality is invaluable for three-colour work, as images taken through blue, green, and red screens are of equal size.

In process work, apochromatic lenses are specially suitable for use in three-colour reproduction. The term is one specially used by Carl Zeiss to describe lenses for colour reproduction; for example, the "Apochromatic Planar" and "Apochromatic Tessar."

AQUA FORTIS (Latin)

Weak nitric acid. The term was once universally used by chemists for nitric acid, whether dilute or not.

AQUA REGIA (Latin)

So called because it dissolves the noble metals; a mixture of 3 parts of nitric acid and 1 part of hydrochloric acid. It is used for dissolving gold and platinum, as, for example, when making gold chloride, the metals being insoluble in the separate acids. Its solvent action depends upon the fact that it contains free chlorine, liberated by the oxidizing action of nitric acid upon the hydrogen of the hydrochloric acid.

AQUA VITÆ (Latin)

An old name for alcohol (*which see*).

AQUARELL PROCESS

A combination of half-tone and chromolithography for colour printing, practised in Germany. Also known as aquarell facsimile reproduction, aquarell imitation, and aquarell gravure. The last-mentioned is really a combination of colour plates with collotype.

AQUATINT (*See* "Gum-bichromate Process.")

AQUATINT ETCHING PROCESS (Fr., *Aquatinte;* Ger., *Aquatint Manier*)

An old method of forming a ground, or tint, for etching on copper. Resin is dissolved in alcohol, the proportion of the latter determining the firmness or coarseness of the grain, and this solution is poured on the polished copper plate. As the alcohol evaporates the resin reticulates into a granular structure. The plate is slightly etched, and then certain parts are stopped out corresponding to the tones of the picture. Further etchings and stoppings out follow until the complete picture is formed in graduated tones. Usually the plates are printed from by the intaglio method, but the method has also been applied in connection with photo-processes for typographic colour work.

AQUATINT, PHOTO (*See* "Photogravure.")

ARABIC, GUM (*See* "Gums and Resins.")

ARABIN (Fr., *Acide gummic*)

The pure, soluble principle of gum arabic, and existing in different proportions in different samples. In good Soudanese gum the proportion of arabin is between 78 and 80 per cent.; in Turkey gum about 40 per cent. It is used in the arabin gum-bichromate process, under which heading a method of preparing arabin is given.

ARABIN GUM-BICHROMATE PROCESS

A gum-bichromate printing process, worked out by Nelson K. Cherril, and published in June, 1909. To prepare the arabin, a quantity of best Soudan gum arabic is sifted through a 40-mesh sieve. Place in a quart earthenware jar 150 ccs. of water, 7½ ccs. of pure hydrochloric acid, and then sift into the mixture, stirring the while, 100 g. of the powdered gum. Keep the whole at about 120° F. (about 49° C.), and stir frequently until solution is complete. Cool and add 600 ccs. of the best methylated alcohol, free from petroleum, and stir for half an hour or so, or until the arabin is thrown down as a white precipitate and has lost all stickiness or gumminess. Filter through two thicknesses of cheese-cloth, gather the arabin in the cloth into a ball, and squeeze it well, place it in a small jar, cover with new spirit, stirring it and breaking it up well, and leave for several hours until the spirit has absorbed all the water. Squeeze again in cheese cloth, then put the arabin in a towel and squeeze it in a press, with as heavy pressure as possible. Break up the cake formed, to allow the remaining alcohol to evaporate, with gentle heat; then break the remaining lumps in a mortar and dry until all is a dry, gritty powder. The formula in the English system would be roughly as follows:—

Water	5¼ oz.
Hydrochloric acid	127 mins.
Powdered gum	1540 grs.
Methylated alcohol	21 oz.

To prepare synthetic gum, take 20 g. of arabin, 20 g. of heavy magnesium carbonate, and from 40 ccs. to 75 ccs. of water, according to the thickness of the solution preferred for coating. This formula in English is —

Arabin	308 grs.
Magnesium carbonate	308 ,,
Water	1½ to 2¼ oz.

When mixed, stir occasionally until the froth subsides, then filter through muslin.

To prepare the pigment, lampblack is used; wash it with repeated doses of mixed ether and acetone until all fatty, gummy matters are removed; or, preferably, burn small pieces of camphor slowly under a piece of porcelain—say the bottom of a porcelain developing dish. Scrape off the soot with a palette knife into a test-tube and wash with mixed ether and acetone until these solvents come away with only slight discoloration. Pour off as much as possible without losing the black, and dry by stirring the test-tube in hot water, keeping the water from the pigment. When dry, the tube is inverted, and the black will fall out freely. A special lampblack, known as No. 4, has been prepared for this particular process. To mix the gum and pigment for coating upon paper, it is necessary to experiment with the particular paper to be used, taking a normal temperature —say 95° F.—for the developing water and a normal time—say forty-five minutes—for development. The mixture must be such as will just soak clean from the paper in the development time. With too little gum the pigment soaks into the paper; with too much, it washes away before development is complete. In practice it is best to make up an under-gummed and an over-gummed ink, and experiment with these will show the proportions for any paper. For instance, Cherril recommends the making of one ink containing gum in the proportion of 20 arabin to 75 water, and the other in the proportion of 20 to 45 of water. If both these are pigmented in the same proportion as to quantity—that is to say, about 400 to 500 mm. of lampblack to each 10 ccs., the one will be found to give too much penetration to Joynson's or Rive's paper, and the other too little; a mixture of the two will be found to give a good result. The mixture is sensitised just before use by an addition of an equal volume of bichromate solution made by adding 15 g. (230 grs.) of ammonium bichromate to 100 ccs. (3½ oz.) of water; dissolve by heat, and neutralise by stirring in a little chalk, decanting when effervescence ceases and the solution settles. The paper to be used is brushed over thinly with the freshly-mixed gum and bichromate, the brush marks being obliterated by crossing and recrossing the strokes. After drying, the paper is ready to be exposed. Exposure should be by actinometer after the manner of carbon, and the paper is much more sensitive than the average gum-bichromate paper prepared by other processes. If the development of a print from an ordinary negative is complete in about forty-five minutes in water at a temperature of 95° F. (35° C.), the result will be perfect. Development may be performed in a vertical tank by floating face downwards on the water, only "controlling" in the usual manner. (For particulars of gum work in general, *see* "Gum-bichromate Process.")

ARAGO, DOMINIQUE FRANÇOIS

An eminent French astronomer and physicist (*b.* 1786, *d.* 1853), to whom Daguerre showed and explained his earliest results. Daguerre's discovery was communicated to the Paris Academy of Science by Arago on December 7, 1839, and it was on the latter's recommendation that the French government awarded Daguerre a life pension of 6,000 francs, on condition that he published the process.

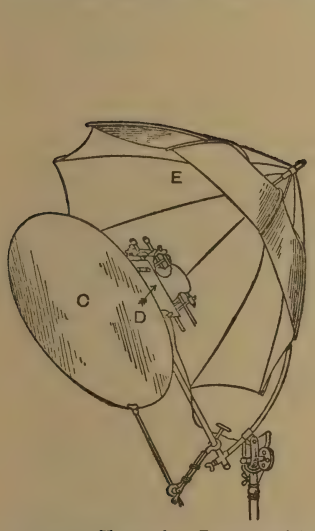
ARC LAMPS (Fr., *Lampes à arc*; Ger., *Bogenlampen*)

Lamps in which a powerful light is obtained by passing an electric current through a pair of slightly separated carbon pencils. Where the current is interrupted by the gap an intensely brilliant arc is created. Arc lamps are of two principal kinds: (*a*) open, in which the carbons are exposed to the air, and (*b*) enclosed, in which the carbons are almost hermetically sealed in a glass-covered case, and burn in a mixture of carbon monoxide and nitrogen formed by their own combustion. The enclosed type is coming

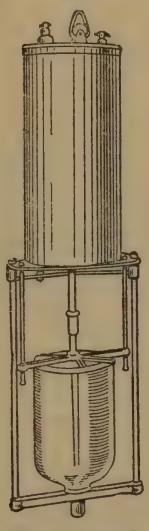
to be preferred, on account of its increased actinic power, due to its larger arc, the greater proportion of violet rays, and the fact that the life of the carbons is much longer, owing to the practical absence of air, and consequently slower combustion. Some excellent open-type arc lamps are, however, obtainable, in which several pairs of carbons are used; these obviously yield a more powerful light than the single carbon pattern.

The arc light is employed in studio portraiture, printing, copying, enlarging, and photomicrography, also in the optical lantern and cinematograph.

In studio work the lamp should be supported on an adjustable tripod or bracket, so that it may be raised as high as 8 ft. or 9 ft. or lowered at will. The direct light of the arc is liable to produce hard lighting and heavy shadows; and it is therefore advisable either to cut this off by a small opaque disc placed in front of the carbons



A. Open Type Arc Lamp, with Diffusing Screen, etc.



B. Enclosed Arc Lamp

and to use only the light obtained from an umbrella reflector or screen at the back of the lamp, or, as an alternative, to use a translucent diffusing screen of muslin or tracing cloth in front of the lamp. Sometimes these two plans are combined. A illustrates the use of a diffusing screen C with the Boardman multi-carbon arc lamp (open type). The metal shield D screening the direct light of the arcs will be noticed, and also the large umbrella reflector E. B shows an extensively-used pattern of enclosed arc (the "Westminster") designed for general photographic use. For low studios, a reversed model is made, having the arc chamber on top instead of beneath. Whatever kind of lamp is employed, the lens must be shielded from the direct rays by means of a projecting hood.

For printing, the lamp should not be too near the frames, a good average distance being 2 ft. or 3 ft. Various stands are obtainable to support a number of frames in circular tiers, the lamp being suspended in the centre.

In lantern and cinematograph work the open arc at present holds the field, though the enclosed arc is coming into use. Lantern arc lamps are so designed as to economise space, and are fitted to a sliding tray. A model having the carbons at a right angle is claimed to give a better and more direct light, and to take up less room than those types in which the carbons form a very obtuse angle with each other.

In process work, arc lamps play an important part, practically all work being done by electric light, because of its uniformity and the certainty of the exposures as compared with daylight. The "open" arc has been almost entirely superseded by the "enclosed" arc. For copying, a pair of lamps is usually employed taking about 10 amperes, though for large work four lamps may be necessary. The lamps are enclosed with semi-cylindrical reflectors, which are whitewashed inside. For colour work 15 ampere lamps are frequently adopted, and coloured flame carbons utilised to aid the exposure through the colour filters. Red flame carbons, for instance, are found beneficial with the red filter for the blue printing plate. Search lights of high amperage are also employed in some studios for securing very powerful illumination. For printing on the metal, lamps of from 15 to 20 amperes are employed. Arc lamps for process work are usually run in "parallel"; and a high voltage—200 volts or more—is preferable with enclosed lamps so as to obtain about 140 volts across the arc, by which means a long flaring arc of great actinic power is obtained.

ARCHER, FREDERIC SCOTT

Born at Bishops Stortford, 1813, died in London, May, 1857. He invented the wet collodion process in 1848, and published working details in *The Chemist*, dated March, 1851, his own "Manual of the Collodion Photographic Process" following in 1852. His process practically displaced both the Daguerreotype and Talbotype (calotype) processes, and enjoyed popularity from 1855 to 1880. Many historians have coupled other names with Archer's, either as assistants or co-inventors, but close study of all the facts leads inevitably to the conclusion that Archer deserves the whole of the credit. He introduced pyrogallic acid (then sold at 6s. 8d. per dram) as a developer; a camera within which plates could be exposed, developed, and fixed; a triple lens to shorten the focus of a double combination lens; and a method of whitening collodion positives upon glass (*see* "Alabaster Process"). Archer lived and died a poor man; and at his death a subscription list was opened and a sum of £747 raised for his widow and children. Mrs. Archer died shortly afterwards (March, 1858) and the amount was settled upon his children, together with a Government pension of £50 per annum. *Punch*, referring to the testimonial, said (June 13, 1857): "To the Sons of the Sun.—The inventor of collodion has died, leaving his invention unpatented, to enrich thousands, and his family unportioned to the battle of life. Now, one expects a photographer to be almost as sensitive as the collodion to which Mr. Scott Archer helped him. A deposit of silver is wanted (gold will do), and certain faces

now in the dark chamber will light up wonderfully, with an effect never before equalled in photography. . . . Now, answers must not be negatives."

ARCHEROTYPE, AND ARCHOTYPE

The early names (after Archer, the inventor) of the collodion process.

ARCHITECTURAL PHOTOGRAPHY

In photographing architectural subjects, whether for pictorial or record purposes, regard must be paid to the fact that technical correctness is absolutely essential. Many technical points that can be ignored without any serious disadvantage in landscapes become important in architecture, and disregarding them would involve serious loss of quality. The camera back must be kept upright so as to secure vertical lines in the photograph; it should be tested with a level or a plumb indicator. The one exception to this rule is that in many old buildings the walls lean outwards, the heavy pressure of the roof, acting for centuries, having forced them into that position. In that case, the camera may be tilted slightly, the back leaning backwards, so as to bring the walls or columns vertical in the photograph. Wide-angle lenses, or those that include a large expanse of view, become a necessity in most architectural work. In exteriors as well as interiors, the space is frequently too limited to allow a distant point of view to be taken, and a lens that will include sufficient of the subject from a very short distance becomes necessary. Although this is by some regarded as a disadvantage, it cannot in every respect be so considered. Photographing a subject from a near point of view possesses one distinct advantage. It conveys the impression of looking upwards in a manner that cannot be attained by any other means; and this frequently adds impressiveness to the picture. Small portions or details can be effectively taken with a lens that would be suitable for general landscape work, but larger subjects require the shorter focus instrument. The most useful wide-angle lens will have its focus about four-fifths of the longer side of the plate; and if the worker has a second lens, its focus should be about the same as the longer side of the plate. And the ordinary landscape lens—one and one-third the length of the plate—will be useful for those subjects that provide sufficient space. The lens, whatever may be its focus, should be capable of covering a much larger area than the plate in use. In many subjects the lens has to be raised considerably above the centre of the plate, and, unless the lens will cover when it is so raised, dark empty corners will appear on the negative. Tilting the camera to accommodate a lens of limited covering capacity is very undesirable; the front and back not being parallel necessitates the use of a very small stop to secure sharp definition.

The camera should be simple and rigid, so that long exposures may be given without any risk of vibration. The rising front should allow the lens to be raised well above the centre; almost as far as the top edge of the plate is occasionally required. Within reasonable limits, the greater the rise obtainable, and the greater the covering power of the lens, the more useful and adaptable will be the apparatus for architectural subjects. An anastigmat possesses so many advantages that no other type of lens should be employed.

In all subjects an oblique position rather than a full front view should be chosen. The latter destroys the effect of relief, whereas the former shows it effectively. It is very rare that a full front view of any subject is effective; the result is almost always flat and lacking in interest, as the projection of one part of a subject beyond another is lost in the picture. A wide-angle lens is frequently valuable in enabling the photographer to select a more oblique position than would otherwise be obtainable.

A liberal proportion of foreground should always be included in front of the nearest important vertical object; it assists in conveying the impression of space. The normal height of vision—5 ft. from the ground—is the best for all large or high subjects; it conveys the most natural impression of size. Photographing from a height dwarfs the effect of the building, and should be adopted only for special purposes. At times the camera may be much lower than 5 ft., especially for small subjects taken with a wide-angle lens. (*See* "Interiors, Photographing.")

Symmetry in the arrangement of the subject on the plate should be studiously avoided; and, equally, an arch, a column, or a doorway that may form an important part of the subject should never be shown almost but not quite completed, broken by the boundary line of the picture. It conveys the sense of incompleteness and absence of support. Sunlight is very effective in some exterior work, especially in comprehensive views of large buildings. In smaller subjects, too, it is frequently a valuable aid to picturesque quality. At times, the sun shining almost along the principal face of the building photographed will produce exceptionally good effect by throwing very long shadows of all projecting details. In many small details, direct sunshine is best avoided in order to show the form and surface of the details free from cast shadows. When photographing in sunshine a full exposure is absolutely necessary in order to secure transparency and full detail in the shadows. (*See also* "Interiors, Photographing" and "Exteriors, Photographing.")

AREA SYSTEM OF STOPS

An obsolete system of marking lenses and stops suggested in 1886 by George Smith. Every stop and every lens had its own number, and the relation of the stop number to the lens number was supposed to indicate the correct exposure.

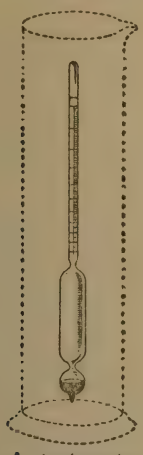
ARGENTIC SALTS, OPALS, ETC.

Argentic salts are salts of silver; argentic opals are opals sensitised with silver. *Argentum* is the Latin name, and *Argent* the French name for silver. Sensitised materials of one particular make are called argentic opals, paper, etc., but bromide opals, paper, etc., are more popular names.

ARGENTOMETER (Fr., *Argentomètre, Pèse Nitrate;* Ger., *Argentometer, Silbermesser*)

This instrument is used by wet collodion

workers for testing the strength of the silver bath. It consists of a hydrometer which is floated in a tall glass jar. The hydrometer is graduated either to show grains per ounce of water, parts in a certain volume of water, or percentages. The first-mentioned is most



Argentometer

commonly employed by English workers, and the second or third by Continental workers. The reading is only accurate in case of a new bath, as by use the bath becomes charged with iodising salts and alcohol from the collodionised plates, but for all practical purposes it forms a sufficient test.

ARGENTOTYPE

A name for bromide paper, and widely used in the early days of the bromide process.

ARISTOGEN

A concentrated one-solution hydroquinone developer, introduced by Liesegang, consisting of hydroquinone, sodium acetate, sodium sulphite, and citric acid, for developing faintly printed-out gelatino-chloride and collodio-chloride papers. According to Schnauss a similar and suitable formula is :—

Hydroquinone (7 % alcoholic solution)	4 parts
Sodium acetate (15 % solution)	8 „
Water	70 „

ARISTOSTIGMAT (*See* "Lens.")

ARISTOTYPE

A gelatino-chloride P.O.P. The original aristotype paper was simply a paper prepared with a substratum of barium, and coated with a collodio-chloride of silver emulsion, and the term was first used early in the 'eighties, Obernetter, of Munich, being the first to introduce it. The name is still used by some makers of P.O.P., both gelatino- and collodio-chloride, especially in America.

AROMATIC CARBON COMPOUNDS

A very large class of chemical compounds which are derivatives of benzene or contain what is known as a closed chain or nucleus similar to benzene. Generally, they contain a larger percentage of carbon than the fatty or aliphatic compounds, and are more frequently crystalline at ordinary temperatures, and more easily converted into substitution products, especially by the action of nitric and sulphuric acids, which produce nitro and sulphonic derivatives. Most of the newer developers belong to this class.

ARROWROOT (Fr., *Arrowroot;* Ger., *Pfeilwurzelmehl*)

A prepared pure starch obtained from various plants, the finest being the West Indian, of which the source is the rhizomes of *Maranta arundinacea.* English arrowroot is the starch obtained from potatoes. Arrowroot is used for sizing papers before sensitising and also as a mountant.

ARTIFICIAL IVORYTYPES

Photographs made in 1857, by Mayall, on a paper substitute prepared by mixing barium sulphate with albumen, and rolling the paste into sheets. These, when dry, were printed upon and used as paper.

ARTIFICIAL LIGHT

Thanks in no small measure to the introduction of rapid plates, and of lenses working at very large apertures, artificial light has become of inestimable service in photography. It is used for lighting the subject, for illuminating the darkroom, and for printing. The actinic power is obviously important, and the following table gives the approximate comparative powers of the illuminants in common use, a standard candle being taken as 1 :—

ACTINIC POWERS OF ARTIFICIAL LIGHTS

Standard candle	1
Colza lamp, ½-in. wick	2
Paraffin lamp, ½-in. wick	4
„ „ 1-in. wick	10
Paraffin duplex lamp	30
2-ft. gas burner	12
5-ft. „ „	35
16-c.p. electric incandescent lamp	35
32-c.p. „ „ „	70
Welsbach incandescent gas	80

Sir William Abney gives the following table, showing the photographic value of some artificial lights in terms of the photographic value of a standard candle, the photographic value being taken as the effect on bromide of silver :—

Light of the Optical Value of one Standard Candle	Photographic Value in Terms of Standard Candle
Standard candle	1
Ordinary paraffin candle	1·3
Oxyhydrogen light, blow-through jet	2
Electric arc light	10
Magnesium burnt at the rate of 1 gr. per minute.	15
Bright sun at noon in summer	21·6

Referring to the above, Sir William Abney says: "It will be noticed how the optical and photographic values differ. It might be thought that, although these differences do exist, yet, by increasing the smaller number, the same effect

might be obtained. It must be recollected, however, that the electric light radiates from 1,000 to 10,000 candles from a very small area, and that, to make the same photographic illumination, the number of candles would have to be the same, but multiplied by 10. Thus, if an electric arc light radiated 1,000 candles, the number of standard candles that would have to be employed would be 10,000, a number which would never be concentrated in any reasonable area. Sunlight may be taken as equal, optically, to 5,600 candles placed at one foot from the object illuminated."

The electric arc and the mercury vapour lamps are the most powerful for photographic purposes, and largely used by professional workers because of their richness in those rays to which dry plates are the most sensitive. The light from incandescent electric lamps is usually of a yellowish tint, serviceable enough for printing, dark-room illumination, etc., but hardly strong enough for portrait work unless used in large numbers. Acetylene gives a very serviceable and intensely actinic light for most photographic purposes. The artificial light that is most generally used for printing, however, is the incandescent gas mantle, which, when of an average quality and full size, gives a light of between 60 and 70 candle power. Magnesium, in the form of either powder or ribbon, is extensively used for portrait work outside the studio at night, its use dating from 1863. Ribbon and powder, weight for weight, give approximately the same illumination; and one inch of ribbon in contact printing is equal to four minutes' exposure to an ordinary flat flame gas burner at the same distance (*see also* "Flashlight Photography"). In 1882 a lamp was devised for burning magnesium ribbon in oxygen; a number of improvements followed, and the lamp is now an article of commerce. Ordinary gas burners, oil lamps, and candles give lights that are of poor actinic value. As regards the cost of some illuminants, Leon Gaster, A.M.I.E.E., has given the following table:—

	Cost per 1,000 hours per candle power.
Petroleum	9·08d.
Alcohol incandescent	10·03d.
Auer burner, incandescent gas	3·17d.
Pressure gaslight, incandescent	2·12d.
Carbon filament lamp	14·11d.
Nernst lamp	8·82d.
Arc lamp	5·18d.
Flame arc lamp	1·06d.

(*See also* "Acetylene," "Flashlight Photography," "Candle Power," "Limelight," "Artificial Light, Portraiture by," etc.)

ARTIFICIAL LIGHT, PHOTOGRAPHY BY

Photography by artificial light presents no serious difficulty if proper precautions are taken, and a correct exposure given. It is imperative that the source of light should be in such a position that no direct rays reach the lens. When it is unavoidable that the source of light is in front of the camera, the lens may have fitted to it a sky-shade or a large temporary hood, so as to protect it from the light. Whenever possible, the source of light should be behind the camera, not directly at the back, but at one side or the other. Where the arrangement of the light is under the photographer's control, and the light is of such a nature that it can be divided, the larger part should be placed at one side and behind the camera, and the smaller part at the other side. Even where the light is fixed, but divided, as with two or more electric arc lamps, a similar result may be obtained by placing the camera so that one light is almost directly behind it, slightly to one side, and the other one considerably towards the other side. When practicable, the light should be diffused by a screen of tissue paper. This softens the light, and destroys the harshness of the cast shadows, which would otherwise be very strongly marked.

When photographing an interior, or a small object in a building, by electric arc lamps, the strength or actinic value of the light may be tested by means of an actinometer while the camera and subject are being arranged. For a room about 40 ft. by 25 ft. or 30 ft., with the camera and a single arc light of about 2,000 candle power at one end, the exposure should be ten minutes, using a lens aperture of *f*/16 and a plate of a speed of 200 or 250 H. & D. For a small object photographed at a distance of 6 ft. or 7 ft., illuminated by a single arc light of 2,000 candle power at a distance of 10 ft. or 12 ft., the exposure should be five or six minutes for a light-coloured object, up to twelve or fifteen minutes for one of dark colour.

Where arc lamps are not available, magnesium ribbon or powder, or a mixture of magnesium and aluminium, may be employed. The powder is frequently burned in the form of a flash, and though this may be desirable when groups of persons have to be included, the methods in which the powder is burned more slowly are preferable. Magnesium alone produces considerable smoke in burning, and though this smoke is only in evidence after the exposure is completed, it is a serious objection in many cases, and quite prohibits making a second exposure. (*See* "Flashlight Powders.")

A convenient form of artificial light easily obtainable is that sold under the name of "Flash Candle." These candles consist of a celluloid tube filled with a perfectly safe mixture which burns for a few seconds and produces a light of great intensity. They are obtainable in various sizes, called two-second, four-second, and seven-second candles respectively. Two, three, or four of these may be placed in suitable positions for lighting an interior, and they may be lighted in rapid succession by applying a lighted taper to the touch-paper with which each candle is provided. Focusing and arranging must be done before lighting the candles. A room or space about 25 ft. by 16 ft. would be sufficiently illuminated if the camera and lights were at one end and two four-second candles were burned, using a lens aperture of *f*/16 and a plate having a speed of 200 or 250 H. & D. As in the exposures given for electric light, it is assumed that there is a wall near the lights, or an equally well-lighted space beyond. If these candles or an electric light were used to illuminate a small space which formed part of a large room

or open space, in such a manner that there was a large open dark space beyond the light, at least half the illumination would be lost by diffusion.

Still life and flower photography may be carried out very successfully by artificial light, using either magnesium ribbon or the flash candles. One four-second candle at a distance of 3 ft. should be sufficient, using the lens at *f*/16 and a 200 H. & D. plate; a screen of ground glass or tissue paper for diffusing the light is imperative, and a white reflector behind it.

Copying may be done in a similar manner, or by means of the ordinary gas or electric house lighting. Two lights should be used if possible, one placed at each side of the camera, so as to light the work to be copied as evenly as possible; or half the exposure may be made with a single light at one side, and then the light placed at the other side for the remainder of the time. When copying a print with a glossy surface, care must be taken to avoid the sheen that may be produced by an improperly placed light. For copying a photographic print, the same size as the original, using a 50 candle-power gas or electric light placed about 2 ft. from the print, the exposure required for *f*/16 and a plate 200 H. & D. would be about five minutes. For copying a black print on plain white paper—a line engraving, for example—two minutes would be sufficient.

For rapid work by artificial light, *see* under the headings "Flashlight Photography" and "Flashlight Powders." For the application of artificial light in the production of prints, *see* under the headings "Bromide Paper" and "Gaslight Papers and Lantern Slides."

ARTIFICIAL NEGATIVES

Hand-made, and not photographic negatives; known also as factitious negatives. An opaque ground or varnish is spread on glass, and, when dry, is scratched through with a needle point, making a drawing after the style of an etching. The process is also used for making lantern slides (positives) of diagrams, writing, etc. Asphalt varnish to which wax is added until a pliable ground is obtained makes a suitable coating. If the ground is sticky or is not dense enough it may be dusted over and polished with fine blacklead, such as is used by electrotypers. White grounds may also be formed by dusting with *blanc d'argent*. A wet plate may be fogged, developed, and intensified to form a ground; and there are numerous other methods of preparing such plates.

ARTIGUE PROCESS

A modification of the carbon process, named after its inventor, Mons. Artigue. No safe-edge is necessary on the negative, there is no transfer, and consequently the print is not reversed. The paper for this process is supplied coated with a mixture of a colloid substance and a very fine black pigment. It is supplied insensitive, and requires to be sensitised by floating on a 2 per cent. solution of potassium bichromate. A thin negative is most suitable for this process, and the exposure of the print is timed by means of an actinometer as in ordinary carbon printing. An essential feature of the process is the method of development. A very fine sawdust is supplied by the makers of the paper; this has to be mixed with water to about the consistency of a thick soup. The print is soaked in tepid water for a few minutes, and then laid face upwards on a sheet of glass. The sawdust and water mixture, preferably tepid, is poured over the print from a jug. The print is rinsed from time to time so that the progress of development may be judged, and the pouring of the sawdust mixture is continued until the print is sufficiently light, exactly as the pouring of water in an ordinary carbon print. As soon as development is completed, the print is well rinsed to remove any of the sawdust that may adhere, then placed in a 5 per cent. solution of alum for five minutes, rinsed in two or three changes of water, and dried. The surface of the prints is exceedingly delicate, and very great care has to be exercised throughout to prevent injury. The prints produced by this process are characterised by very great delicacy and rich quality. They have a delicate velvety matt surface, the deepest shadows are a rich black with full detail, and the scale of gradation is good.

The Artigue process has never been extensively worked in England. Suggested reasons are the extreme tenderness and delicacy of the coating, which necessitates great care at all stages, and the difficulty experienced in obtaining the materials. The introduction of the gum-bichromate process has lessened the demand for a paper of the Artigue character, and several attempts to introduce a paper somewhat similar have met with very slight success. It must be conceded, however, that none of the substitutes has equalled Mons. Artigue's production in delicacy of surface, in richness of quality, or in gradation.

ARTISTIC PHOTOGRAPHY

A frequently used but somewhat vague term. The idea underlying it is that the producer of a given picture has aimed at something more than a merely realistic rendering of the subject, and has attempted to convey a personal impression. Thus, a landscape may be rendered solely as a topographical view or as the material for conveying the idea of, for example, solitude; an interior may be intended to show architectural detail or to suggest, for example, grandeur The results are consequently either realistic or artistic. The artistic element becomes more pronounced the more the merely mechanical and thoughtless is subordinated to the deliberate and intentional control of the producer.

ARTOGRAPH

An automatic machine, known also as the electric artograph and telautograph, for sending sketches or line drawings along a telegraph wire, invented about 1891 by N. S. Amstutz, of Cleveland, Ohio. According to a description published at the time, the picture was photographed on a "stripping film" of gelatine and potassium bichromate, which, after washing with luke-warm water to remove the portions not hardened by the action of the light, gave a picture in relief, more or less high, according to the tones of the original. The next step was to vary the strength

of current in the telegraph wire according to the variations of light and shade in the picture—that is to say, according to the heights and depths of the etched film. This was done by an arrangement similar to the stylus which moves over the indentations on the wax surface of the phonograph. The point of the stylus passed over every part of the film, and tripped up and down according to the degree of relief. By a multiplying lever its movements up and down were caused to depress a series of keys which completed the electric circuit. If the relief was very low only one key was depressed, and more keys were closed in proportion to the depth of the relief. The current was thus varied in strength according to the degree of relief on the film. At the receiving end the current passed through an electromagnet, which bore with more or less force on a travelling graver, according to the strength of the current, and the design was cut in a surface of wax, from which an electrotype could be obtained for printing purposes. The results published at the time of the introduction of the system were crude.

ARTOTYPE

A name give to an early collotype process in which the plate was given two separate coatings of bichromated gelatine instead of, as at present, one.

ASKAU PIGMENT PRINTING PROCESS

(Fr., *Procédé Askau;* Ger., *Askau-Druck*)

A dusting-on process introduced in Germany by Joseph Rieder, in 1909, in which pure india-rubber (caoutchouc), with a small proportion of asphalt added, is used as the sensitising material. Paper coated with the mixture will keep for a month. It is exposed under a positive transparency, as in other dusting-on processes, and is "developed" with a mixture of sea-sand and a suitable powdered pigment, the latter adhering to the light-affected parts according to the exposure each portion has received. A lac varnish is then sprayed over the print by means of an air brush to fix the pigment.

ASPHALT

The chief of the many synonyms for asphaltum (*which see*).

ASPHALT PROCESS

A process of using asphaltum for photo-etching. (*See* "Asphaltum.")

ASPHALTO-PHOTO-LITHOGRAPHIC PROCESS

(Fr., *La Photolithographie au Bitume;* Ger., *Asphalt-Photolithographie*)

An adaptation of the bitumen process of Joseph Nicéphore Niepce. A lithographic stone is coated with a solution of bitumen in ether, or other suitable solvent, and is exposed to light under a negative. The light-affected parts are rendered insoluble, and the unexposed portions may then be dissolved away by the application of ether. After rinsing and allowing to dry, the stone is wetted with gum water, which is applied with a sponge. When dry, the surface gum is washed off with a slightly-damp cloth and the stone is lightly etched with a very weak solution of nitric acid. It is then rinsed to remove the acid, again gummed, and, when dry, wiped with the damp cloth, after which it is ready for printing from in the ordinary lithographic manner, wetting the stone at each impression. The same process can be employed with zinc or aluminium plates. (*See also* "Photo-lithography.")

ASPHALTOTYPE

A name given to one of the processes for using light sensitive asphalt for making typographic printing blocks. (*See also* "Asphaltum.")

ASPHALTUM

(Fr., *Asphalte, Bitume de Judée;* Ger., *Asphalt, Judenpech*)

Synonyms, asphalt, bitumen, bitumen of Judea, mineral pitch, and Jew's pitch. A natural product of the decomposition of vegetable substances.

The term asphaltum comes from the Greek word for fossil pitch, ἠάσφαλτος (and σφαλλομαι) and signifies an unchangeable body. The Latin word bitumen is derived from *pix tumens.* Geologically, asphalt is, as stated above, a natural product of the decomposition of vegetable substances; and it is found in all parts of the world, most frequently in volcanic neighbourhoods. The principal sources are on the shores of the Dead Sea in Syria (whence comes the name Syrian asphaltum), and in the Great Pitch Lake of the Island of Trinidad; but it is also found in the Lake of Maracaibo (in Venezuela), at Coxitambo (in Peru), at Barbadoes, and in the island of Cuba; whilst in Europe there are deposits at Seyssel and at Bechelbronn (in Alsace). Small deposits have been found in Cornwall, Derbyshire, and Shropshire. For photographic processes, however, only the Syrian and the Trinidad asphaltum are considered, these having the characteristic properties of asphaltum—namely, brownish-black colour, high melting point, and conchoidal fracture. Bitumen has usually been considered to be formed by the oxidation of petroleum, and according to the generally accepted analysis is composed of carbon, hydrogen and oxygen, with a small quantity of nitrogen, together with sulphur and mineral substances (iron, manganese and calcium). Syrian asphalt comes into the market in large pieces, which frequently contain small lumps of earthy substances consisting of carbonate of lime, gypsum, clay, and sand. Trinidad asphalt also comes into commerce in large pieces, which, however, do not contain the earthy particles found in the Syrian. The commercial asphalt can be purified by boiling in water, when the pure asphalt melts and floats upon the surface while the impurities subside. The Syrian asphalt begins to melt at 275° F. (135° C.), and the Trinidad at 266° F. (130° C.). The specific gravity of the former is 1·103, and of the latter 1·96; both kinds behave the same in relation to solvents. They are partly soluble in alcohol and ether, more so in benzole, completely and easily soluble in chloroform, bisulphide of carbon, tetrachloride of carbon, turpentine and the various mineral oils. They are insoluble in solutions of caustic potash or soda, weak or strong, hot or cold. With concentrated sulphuric acid the Syrian asphaltum is decomposed, but only by the heat, with evolution of sulphurous acid, and it dissolves into a dirty

brown fluid. Concentrated nitric acid has but very little action on it, even with heat.

The results of analysis show that the Syrian and Trinidad varieties are similar in composition. Each is found to contain 10 per cent. of sulphur, and this constitutes an important factor in regard to photographic sensitiveness. By successive treatment with boiling alcohol, boiling ether and chloroform, it is found that both kinds may be separated into three components, differing in their chemical composition and photographic properties. The portion (*a*) insoluble in ether shows the highest sensitiveness, (*b*) the substance soluble in ether is less sensitive, and (*c*) an oily substance extracted by alcohol is quite insensitive. The part that is insoluble in ether is, as a rule, easily soluble in chloroform and turpentine, and less so in benzole and petroleum. Syrian asphaltum contains 52 per cent. of the sensitive component, while Trinidad contains only 38 per cent.

Spectroscopically examined, solutions of Syrian asphaltum of the most sensitive kinds show weak absorption bands, whilst the less sensitive kinds show the bands more strongly.

As obtained from dealers, asphaltum is generally fit to be used at once; but, if necessary, it may be purified by powdering it and digesting it with dilute hydrochloric acid, which dissolves the earthy particles. Some authorities recommend a treatment with boiling water, by which soluble and earthy particles may be separated out. In order to obtain the most rapid results, it is desirable to extract the least sensitive constituent of the asphaltum with ether, and use the residue in making the sensitive solution. The simplest way of doing this is to digest the powdered asphaltum in a bottle with an excess of ether, shaking it up from time to time, and, if necessary, stirring it with a glass or wooden rod. The ether is changed at intervals of a few hours, till all or nearly all the soluble constituents are removed. The last ether is then poured off, and the residue thoroughly dried. Husnik's asphaltum, which is believed to be prepared in some such way, is obtainable as an article of commerce in the dry powder form. The solvent used for making up the sensitive solution is generally benzole, which should be quite free from water. Sometimes chloroform is added, and generally some essential oil, such as lavender or lemon, which prevents the too rapid drying of the coating, and so keeps it uniform; the addition of oil is said to increase sensitiveness.

The following is a practical formula for preparing a sensitive solution of asphaltum for coating zinc plates for etching: Dissolve 150 grs. of finest powdered Syrian asphaltum in 2 oz. of chloroform and 3 oz. of anhydrous benzole. Add 30 grs. of Venice turpentine and 10 drops of oil of lemon or oil of lavender. The film should be of a transparent golden yellow tint. The coating should be done by means of a whirler (*which see*). The exposure is best made under stripped films, which may be treated with a bath of glycerine to make them adhere when squeegeed down to the plates. It is not necessary to use a printing frame. The exposure may vary from half an hour in the sun to two or three hours in the shade. In bad weather the exposure may extend to days. Development is usually done with turpentine, which dissolves the soluble parts of the image. The scum is rinsed away, and the greasiness removed from the surface with soap and water or a weak solution of soda.

Prof. Valenta has published a process for augmenting the sensitiveness of bitumen by incorporating sulphur with it. By this process, 100 g. (3½ oz. 11 grs.) of raw Syrian asphalt are boiled in a retort with an equal quantity of raw pseudo-cumene—which has the formula $C_3H_3(CH_3)_3$, and a boiling point of about 170° C.—and 12 g. (186 grs.) of flowers of sulphur which should have been previously dissolved in the pseudo-cumene. When after about three or four hours' boiling, the evolution of sulphuretted hydrogen has ceased, the pseudo-cumene is distilled off and the black pitchy residue dissolved in benzole in the proportion of 4 to 100, which solution is used for the sensitive coating of the plate or stone. The sulphurised asphalt prepared in this way is almost insoluble in ether, but dissolves fairly readily in benzole, toluene, xylene, cumene, and turpentine, and is very sensitive to light. Recently Prof. Valenta has simplified his method by dissolving the asphaltum in carbon disulphide and adding sulphur chloride.

A number of processes mostly used for photo-lithography take advantage of the fact that when bitumen is dissolved in both alcohol and ether in suitable proportions it will split up into a grain on drying. The film can then be printed under an ordinary continuous tone negative and yield a picture in half-tones. The Frey process is a successful method worked on this basis.

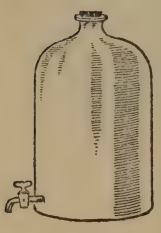
Bitumen processes are not much employed nowadays, owing to the slowness and uncertainty of the exposures. Bitumen powder is, however, largely used for dusting on plates to strengthen the resist for etching, and the solution is used as a resist varnish for the backs and margins of plates, and for stopping out.

Alberini's reversed bitumen process consists in removing the exposed bitumen from the metal plate instead of the unexposed bitumen as in the ordinary process. This makes it possible to expose the bitumenised zinc plate under an engraving, print, or inked drawing on thin paper, dispensing with the use of a negative. The preparation of the plate and exposure follow on the lines of the ordinary process, but development is effected by immersing the plate in a dish of 40 per cent. alcohol. The principle of the process is that the alcohol dissolves the part which has been acted on by light, and not the unexposed part, which is usually developed with turpentine.

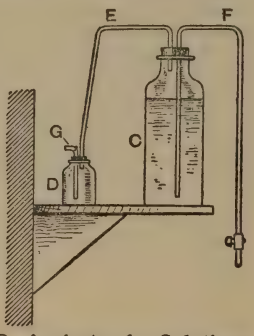
ASPIRATOR

An instrument used to promote the flow of gas or liquid from one vessel to another by suction. In its simplest form it is a cylindrical glass or other vessel having a pipe to admit air at the top and a stop-cock at the lower end. A shows a simple form of aspirator bottle. As a container for solutions which must be kept in bulk free from air, it is shown at B. The large bottle C contains, say, a hydroquinone-metol developer and has two glass tubes, one of which F reaches to the bottom; F passes through a rubber stopper and is continued down below the shelf, having a piece of rubber tubing with a

clip and a piece of drawn-out tube at the end. The other tube E just pierces the rubber stopper, and is connected with a small bottle D containing about 50 grs. of pyro dissolved in 2 oz. of a 10 per cent. solution of caustic soda. The tube from the large bottle just pierces the rubber stopper in the smaller one, while a third tube G goes to the bottom, its other end being open to the air. This tube should be high enough to prevent the pyro-soda mixture being forced out of the bottle. To use the arrangement, unclip the rubber at the end of the tube F and blow through G. This forces the developer up and down the tube F and so creates a siphon, it being then only necessary to unclip the tube to obtain developer from the large bottle down the tube. The solution in the small bottle filters the air from both carbonic acid and oxygen, and the developer keeps good indefinitely. If the depth of the liquid in the small bottle exceeds 3 inches, the tube F should be at least 6 inches below the shelf.



A. Aspirator Bottle



B. Aspirator for Solutions to be kept from Contact with Air

ASPRAY-FISHER ANIMATED STEREOGRAMS (Fr., *Méthode Aspray-Fisher de la Stéréoscopie Animée;* Ger., *Aspray-Fisher Lebendige-Stereographie*)

An invention patented in 1859 by C. Aspray and R. Fisher. The two halves of a pair or series of stereoscopic pictures are so taken as to be views of the same person or object in slightly different positions. By rapidly opening and closing each eyepiece in turn with a revolving disc, so that either eye is alternately eclipsed, the illusion of motion combined with stereoscopic relief is obtained. This is the earliest recorded attempt to combine apparent movement with the effect of natural relief and modelling.

ASTIGMATIC CORRECTOR

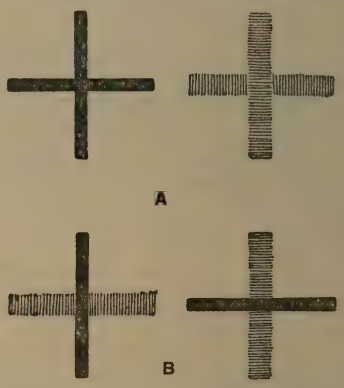
A negative attachment for removing the astigmatism of portrait lenses. It was invented by T. R. Dallmeyer in 1897. Although highly successful in producing a perfectly flat and non-astigmatic field, the corrector was never placed upon the market, as it was found necessary to grind special glasses for each individual lens. The focal length of the portrait lens was increased by from 30 to 40 per cent. with, of course, a corresponding decrease in rapidity.

ASTIGMATION

An old and practically obsolete synonym of astigmatism.

ASTIGMATISM

A serious defect in many lenses by which they are prevented from rendering vertical and horizontal lines with equal degrees of sharpness. It is more noticeable towards the edges of the field, the centre being quite free from it. The defect is best explained by a diagram. If, using a lens defective in this way, a clearly defined cross is focused in the centre of the field, it will go evenly out of focus on moving the screen to and fro, the edges being uniformly blurred as at A. Upon focussing the same cross near the margin of the plate, the vertical or horizontal line only will be blurred, the other becoming sharper as the screen moves to one side or the other of the focal plane of the image, as at B. In like manner, a circle is drawn out into an ellipse either horizontally or vertically, as the case may be. Astigmatism may be minimised by the employment of a small aperture, but cannot be entirely removed. It is usually found in portrait and rectilinear lenses, and may be partly cured by shortening the tube; this, however, has the disadvantage of increasing the curvature of field.



Blurred Images due to Astigmatism

ASTRO-PHOTOGRAPHY. (*See* "Stars, Photographing," "Celestial Photography," "Comets, Photographing," etc.)

ASTROPHOTOMETRY

The use of the photographic plate for astrophotometry is not unattended with disadvantages, for whilst the correction of the instruments may be good it is impossible to bring all the rays to an accurate focus, and they are grouped in rings around the actual image of the star. As the brightness of the star increases, or the exposure is prolonged, the image not only becomes denser, but also widens; therefore it has been suggested to estimate the magnitude of the star both by the density and the increase in diameter, or either. Unfortunately, the law breaks down that increase of the exposure is equivalent to the increasing of actinic luminosity, but it has been found to apply to stars down to the eleventh

magnitude. When the diameter of the star image is used, an allowance has to be made for the duration of exposure, and this has to be determined for every plate and instrument, but may then be taken as constant. When the density of the image alone is used, Pickering and Schwarzschild independently suggested that the out-of-focus images should be photographed when they no longer appreciably differ in size but do in density. One of the chief difficulties to which attention has only been recently directed is the effect of the different colours of the stars, for obviously a blue star and a red star photographed on an ordinary plate and then on a panchromatic or red-sensitive plate would present totally different images, not only as regards size, but density.

ATMOGRAPHY

The name given to the curious effects on sensitive plates and papers caused by emanations and vapours from sugar, eggs, smoke, and other substances, sometimes referred to as effluviography and vapography.

ATMOMETER (Fr., *Atmomètre ;* Ger., *Dunstmesser*)

An instrument for measuring the quantity of water passing into the air by evaporation in a given time.

ATMOSPHERE, RENDERING

In the pictorial sense the word atmosphere is generally used to indicate a certain amount of visible vapour or mist in the air. The presence of mist is frequently a valuable aid to picture making, often imparting a suggestion of delicacy and mystery to subjects that are less satisfactory when the air is clear and the light bright. The rendering of subjects under these conditions is not always easy. The exposure must be carefully timed, and development must be so adjusted as to secure a negative of soft and delicate gradation. The use of a colour screen, or light filter, is generally a disadvantage, as it has a tendency in certain conditions to make the veiled distance clearer and brighter than it appears. The best result is obtained with a full exposure on an ordinary plate, followed by development carried only far enough to secure detail and gradation without blocking up the lighter tones. A delicate grey print in bromide or platinum is frequently the best presentment of the effect.

ATMOSPHERIC ACTION

The atmosphere is a mixture of oxygen and nitrogen containing always more or less carbonic acid and aqueous vapour. In the neighbourhood of cities there is also more or less smoke and traces of sulphur compounds, and occasionally ammonia. All developing agents when exposed, either in the solid state or in solution, to the air greedily absorb oxygen, and they discolour and become less active, the oxidation products not being developers. Silver in a finely divided state, as it occurs both in negatives and prints, is extremely liable to be attacked by any sulphur compounds, particularly when gelatine is the vehicle, as this readily absorbs aqueous vapour and thus brings the deleterious sulphur compounds into more intimate contact with the silver of the image.

ATOMIC WEIGHTS (Fr., *Poids atomiques ;* Ger., *Atomgewichte*)

A term relating to the number of atoms forming a molecule of any element, according to the atomic theory. On the atomic weights are based the molecular or equivalent weights, and a list of these is given in a table to be found under the heading "Solubilities."

ATZPINSEL (Ger.)

A round, mop-shaped brush (*see* illustration) of soft hair, generally marten fur, bound to a wooden handle by means of waxed string varnished with shellac. It is used for brushing

Atzpinsel

the surface of the metal plate in etching, to free the image from scum. It is also occasionally employed in etching on copper with iron perchloride when the plate etches slowly and there appears to be a deposit in the hollows.

AURAMINE (Fr., *Auramine ;* Ger., *Auramin*)

Synonyms, auramine yellow, amidotetramethyl diamido-diphenylmethane hydrochloride. Solubilities, soluble in water, alcohol, and ether. A sulphur-yellow-coloured aniline dye which is sometimes used for making light filters or yellow screens. It is unsatisfactory in this respect, as it passes the bright blue, the extreme end of the violet, and ultra-violet, absorbing only the deep blue.

AURANTIA (Fr., *Aurantia ;* Ger., *Aurantia, Kaisergelb*)

Solubilities, slightly soluble in water, very soluble in alcohol. An orange-coloured aniline dye used for making light filters. Much superior filters can be made with other yellow dyes—that is, filters that do not absorb so much red and orange as those made with aurantia.

AUREOLINE (*See* "Primuline Yellow.")

AURIC CHLORIDE (*See* "Gold Chloride.")

AURIN (Fr. and Ger., *Aurin*)

Solubilities, insoluble in water, soluble in alcohol. A mixture of aurin, methyl-aurin, and corallin aniline dyes occurring in yellowish brown lumps with greenish fracture. It is occasionally used for making coloured spirituous backing.

AURORA YELLOW

A fine yellow pigment used both as a water colour and as an oil colour. It is cadmium sulphide CdS, prepared by passing sulphuretted hydrogen SH through a solution of cadmium chloride $CdCl_2$, the precipitate being washed with hot water and dried. A final treatment

with carbon disulphide CS_2 is desirable, as this removes free sulphur.

AUROTYPE (Fr. and Ger., *Aurotypie*)

A printing process made known in 1844 by Robert Hunt, in which gold chloride was used in conjunction with potassium ferricyanide and ferrocyanide. Hunt published other printing processes in which salts of gold were employed.

AUROUS CHLORIDE (*See* "Gold Chloride.")

AUTOCHROM, OR AUTOCHROM PRINTING

A combination of typographic and lithographic printing used for cheap colour work, such as coloured postcards. The keyplate is a half-tone typographic block, and the colours are filled in with tint plates printed lithographically.

AUTOCHROME PROCESS

A process of screen-plate colour photography invented by MM. Lumière [Eng. Pat. 22,077, 1904; 25,718, 1904; 9100, 1906], based on the use of starch grains, as far as possible of a uniform size, dyed to the necessary colours, red, green and blue violet, mixed and sifted on to glass coated with a tacky surface. The grains are then rolled and any white interspaces filled with a black pigment. The screen-plate thus formed is coated with a panchromatic emulsion. (*See* "Screen-plate Processes.")

The plate is placed in the dark-slide so that the glass side faces the lens, and a black, smooth card should be placed in contact with the sensitive emulsion to prevent any damage to the latter. A yellow screen must be used to cut down the excessive action of the blue violet and blue, and the makers provide special screens for this purpose, though the following, suggested by Von Hübl, has proved satisfactory in practice :—

A.	Tartrazine . .	15½ grs.	1 g.
	Distilled water .	17½ oz.	500 ccs.
B.	Phenosaffranine .	1·5 grs.	0·1 g.
	Distilled water .	24½ oz.	900 ccs.
C.	Gelatine . .	93 grs.	6 g.
	Distilled water .	3 oz.	85 ccs.

640 minims or 38 ccs. of C should be mixed with 168 minims or 10 ccs. each of A and B. Immediately before use, 6·2 grs. or 0·4 g. of æsculine dissolved in 338 minims or 20 ccs. of water with 3 or 4 drops of ammonia should be added to the dyed gelatine; it is important to make the æsculine solution only just before use, as it rapidly discolours. Of this dyed gelatine, 140 minims or 7 ccs. should be coated on every 16 sq. in. or every 100 qcm. The exposure must be determined by meter, or the speed of the plate may be taken as approximately 2 H. & D. or 3 Watkins, but, unfortunately, the speed varies practically both in sunlight and shade, and in winter and summer, this variation being dependent on the spectral composition of the light.

After exposure the plate should be developed, and the developer first recommended was pyro-ammonia, but a later recommendation is the following :—

Quinomet (metoquinone)	62 grs.	4 g.
Sodium sulphite (anhydrous)	278 ,,	18 ,,
Liquor ammoniæ (·880)	4 mins.	0·2 ccs.
Potassium bromide .	15½ grs.	1 g.
Distilled water to .	35 oz.	1,000 ccs.

The duration of development should be 2½ minutes at a temperature of 60° F. (15·5° C.). Many other developers may be used, such as a normal metol-quinol developer or rodinal 1 in 12 for six minutes, amidol, rytol, etc.

As the emulsion is very sensitive to red, the plates must be worked in total darkness or in a deep green light such as is obtained through the following filter, and even then the plate should be exposed to this light as little as possible :—

New Bordeau R 3 % solution . .	2½ oz.	125 ccs.
Tartrazine 4 % solution . . .	3 ,,	150 ,,
Light green S 5 % solution . .	3½ ,,	175 ,,
Glycerine . .	1 ,,	50 ,,
Gelatine 10 % solution to . . .	20 ,,	1,000 ,,

2 oz. or 56 ccs. should be coated on every 100 sq. in. or 645 qcm. Or, in place of the above, fixed-out dry plates may be dyed in tartrazine and methyl violet to form a red screen, which should be placed in contact with one stained with malachite green, and if a brilliant light is used a sheet of tissue paper, stained with tartrazine or malachite green, should be placed between them.

At the conclusion of development the plate should be rinsed for fifteen to twenty seconds, and then immersed in the following reversing bath :—

Potassium permanganate	31 grs.	2 g.
Sulphuric acid . .	170 mins.	10 ccs.
Distilled water to .	35 oz.	1,000 ,,

The plate should remain in this for two or three minutes and then be examined by a weak white light, and if all the metallic silver has disappeared it should be washed for about a minute. It is advisable to keep the above reversing solution in two separate solutions and mix as required.

After dissolving out the primary image of silver and washing, the plate should be exposed, emulsion side up, to white light and then redeveloped, which may be done by the following amidol developer :—

Sodium sulphite (anhydrous)	135 grs.	15 g.
Amidol . . .	45 ,,	5 ,,
Distilled water to .	20 oz.	1,000 ccs.

The original developer, metol-quinol, rodinal etc., may also be used. When the second development has completely reduced the silver bromide, and the picture now shows up in colour, the plate is washed for three or four minutes and, without fixing, set to dry. If the plate is seen to lack brilliancy (due to over exposure) it may be intensified with the following, first immersing for not more than ten seconds in 192 minims of the permanganate solution given above, diluted with 20 oz. of water :—

A.	Pyro . . .	26 grs.	3 g.
	Citric acid . .	26 ,,	3 ,,
	Distilled water to	20 oz.	1,000 ccs.
B.	Silver nitrate .	39 grs.	2·5 g.
	Distilled water .	3½ oz.	100 ccs.

For use mix 50 minims or 11 ccs. of B with 1 fluid oz. or 100 ccs. of A, and immediately apply to the plate and allow to act for three or four minutes, then rinse for a minute or two and clear in the following :—

Potassium permanganate	8½ grs.	1 g.
Distilled water .	20 oz.	1,000 ccs.

for about one minute, and wash. The plate can then be fixed in—

"Hypo" . .	3 oz.	150 g.
Sodium bisulphite lye	1 ,,	50 ccs.
Water to . . .	20 ,,	1,000 ,,

for two minutes and washed and dried by a gentle heat. When dry it should be varnished with—

Gum dammar . .	31 grs.	20 g.
Copal . . .	77 ,,	50 ,,
Carbon tetrachloride to	3½ oz.	1,000 ccs.

or

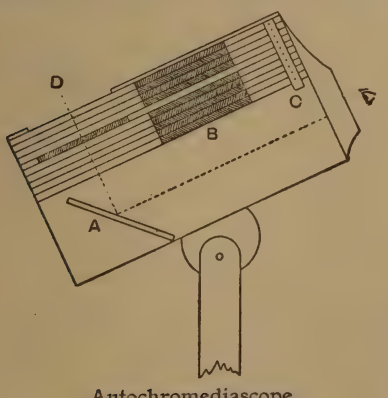
Gum dammar . .	1 oz.	20 g.
Benzole . . .	5 ,,	100 ccs.

When properly treated, and with correct selection of the subject, particularly if glaring contrasts of colours are avoided, very exquisite results can be obtained.

Autochromes have been successfully reproduced by the three-colour and four-colour block processes by illuminating the transparency with reflected light and copying through colour filters, the same as in copying from a painting or other coloured original. The frontispiece to this volume is an example of four-colour reproduction.

AUTOCHROMEDIASCOPE

A reservoir viewing instrument for autochrome and other screen-plate pictures. The transparency is viewed, not directly, but reflected



Autochromediascope

in a mirror as at A. The plates are held in grooves B, and any given one may be brought from the grooves (by means of levers C) to the open position D, and so receive illumination from the sky. A ground-glass screen is placed over the opening at the top, in order to diffuse the light. The viewing box is mounted on a rotating head, by which it can be tilted to any convenient angle.

AUTOCOPYIST

A simplified process of collotype, in which the glass plates for bearing the printing image are replaced by parchment paper, which is coated with gelatine, immersed in bichromate solution, dried, and exposed under a negative, after which it is washed, stretched over a bed-plate, inked up and printed from in the usual collotype way. The printing is done by means of an ordinary letter-copying press, or similar means.

AUTOGLYPHIC PROCESS

A method invented by Duncan C. Dallas, by which a drawing was made on a metal plate by means of a heated pen and a wax composition. The plate could be printed from without etching.

AUTOGRAPHY

A process of lithographic printing simplified for the reproduction of writing in facsimile. The writing is done on a hard, smooth-surfaced writing-paper with transfer ink, and then transferred to stone or zinc in a press. In some processes the paper was damped on the back with water; in others with acid, and in one process blotting paper soaked in turpentine was applied to the back of the sheet. The process has also been applied to type-written sheets, and to crayon drawings on grained paper.

AUTOGRAVURE

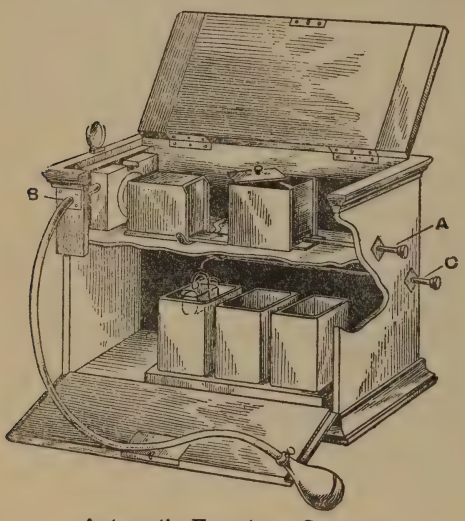
A photo-mechanical process modified from the well-known photogravure process, the resist image being formed by a special carbon tissue manufactured by the company that works the system.

Autogravure is also the name of a process worked by a firm in Vienna for reproducing paintings. Negatives are made for yellow, red, blue, and grey printings. Positives are made from the first three, and from these half-tone negatives are made. These are printed on to stone, zinc, or aluminium for lithographic printing. Further printings are added if necessary from the same negatives in other shades of ink. From the fourth negative an embossing plate is made to give relief to the picture.

AUTOMATIC PHOTOGRAPHY (Fr., *La Photographie Automatique*; Ger., *Automatische Photographie*)

A term frequently applied loosely, and referring strictly only to apparatus that carries out the entire operation of making a finished photograph. To this class belongs the automatic machine exhibited by M. Enjalbert at the Paris Exhibition of 1889. Full directions to the sitter were shown in turn at the proper times on the face of the machine, which was started by dropping a specified number of coins into a cash-box. The duration of the exposure was indicated by the ringing and cessation of a bell, and a finished ferrotype portrait was delivered in about five minutes. Apart from the liability to get out of order, the great drawback to apparatus of this

description is that it cannot make allowance for the sitter's possible inattention to instructions, or for variations in light or temperature. Partly automatic machines, with an attendant or operator, have in consequence enjoyed greater popularity. The illustration shows a typical so-called automatic camera of the kind used by itinerant photographers and at exhibitions



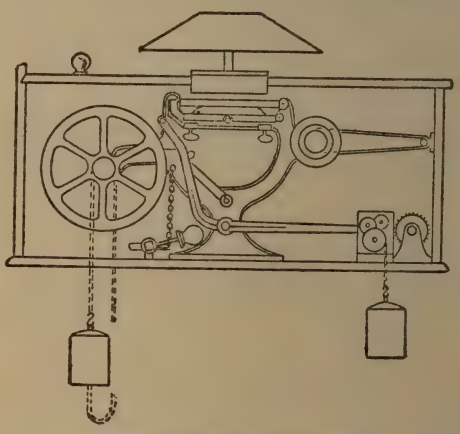
Automatic Ferrotype Camera

The box in the centre of the upper shelf is filled with forty ferrotype plates in sheaths, which may be inserted in daylight, a heavy lid being then placed on top to keep them flat. On drawing out and returning the rod A, which is attached to a plunger, the bottom plate is pushed into a horizontal holder. By turning a milled head at the side, the plate is raised into position for exposure at the back of the small fixed-focus camera shown to the left. Having ascertained that the sitter is correctly placed by inspecting the image in the finder—the small concave lens seen at the top—the exposure is made by pressing the bulb, this being connected to a rubber tube passing to the shutter through B. Any exposure may be given according to the length of time the pressure is continued on the bulb. By means of another small rod in the side the exposed plate is allowed to drop into a wire cradle, controlled by the knob C. The cradle is raised or lowered by turning the knob, while on the attached rod are marked distances to indicate how far it must be drawn out to bring the cradle over each trough in turn. Having allowed the plate to remain in the developer a stated time, the knob is turned to raise the cradle and the rod is pulled out to the distance marked for the fixing bath, in which the cradle is left till the plate is fixed. The knob is then again turned and the cradle transferred in a similar manner to the third or washing tank ; after which the panel in the front can be let down to examine and remove the plate. With a little practice the apparatus is very easily manipulated, a finished positive being obtained in about one minute.

Another branch of automatic photography—or, rather, automatic exposure—is that in which a photograph is obtained by the action, although without the concurrence, of the subject, as when securing pictures of wild beasts in the jungle, or in taking a flashlight portrait of a burglar. The latter undertaking is quite feasible, and various arrangements have been patented for the purpose, in which, for example, the unwelcome visitor is supposed to make an electric connection by stepping on a mat or opening a window, thus rendering a platinum wire red-hot and firing a charge of magnesium flash-powder, while at the same time actuating the exposure shutter of a camera. The one thing against the idea is the fact that the modern burglar would undoubtedly prevent the survival of the record by smashing the camera to pieces. The automatic photography of animals, birds, and reptiles in their natural surroundings is, however, an accomplished fact, and some admirable results have been obtained. The exposure—or, at night, the simultaneous exposure and ignition of flash-powder—is usually arranged by causing the animal or other subject to disturb an electrically connected cord, or to make a contact by treading on a prepared stone, branch, or twig.

AUTOMATIC PRINTING (Fr., *Impression automatique ;* Ger., *Automatisch Druck*)

As early as 1860, Fontayne, of Cincinnati, employed an automatic printing apparatus, by which 200 exposures per minute were possible upon a band of sensitive paper, a large condensing lens being used to concentrate sunlight on the negative. Of later date is a very ingenious clockwork printing machine, patented in 1885 by J. Urie, of Glasgow ; its internal arrangement



Automatic Printing Machine

is shown in the illustration. The bromide paper is used in a continuous band, which, having once been adjusted under the negative, is moved on by the length of one print after each exposure. The light is furnished by a gas burner, and is automatically lowered when the paper travels ; while a flat dish containing water is interposed between the burner and the negative, to prevent the overheating of the latter. The correct exposure having first been ascertained, the

IN WESTMINSTER ABBEY — BY HENRY W. BENNETT, F.R.P.S.

machine may be regulated to repeat it indefinitely as long as it will run, and may be left to itself. Large automatic printing machines, power-driven and electrically illuminated, have of recent years been adopted for the production in quantities of bromide prints, pictorial postcards, etc. Automatic printing machines of a special description are also employed in making the positive film from the negative one for the kinematograph.

AUTOTYPE (*See* "Carbon Process.")

AUTOTYPOGRAPHY (Fr., *Autotypographie;* Ger., *Autotypiegraphie*)

A term sometimes used for relief printing blocks. It has been particularly applied to a process for the making of prints from the leaves of plants and flowers.

A process called by this name was invented by George Wallis, in 1859 and 1860, by which drawings made upon gelatine could be transferred to metal plates, and afterwards used for printing from in the same way as an ordinary copper plate.

AUX DEUX CRAYONS

A style of stained print once popular in America. The print is immersed in a solution of alcohol 3 oz., powdered aloes ½ oz., until stained, or toned, a lemon colour, is then well washed, and placed in 3 oz. of water to which have been added 4 drops of liquor ammoniæ. It remains there until of a warm orange colour, and is then washed, dried, and mounted. The high lights are touched up with Chinese white and the blacks with Indian ink, and the whole is finally coated with a solution of plain collodion 1½ oz., castor oil 4 drops. The process is now obsolete, but for a time was a craze in the United States, where carefully made and artistic examples commanded good prices.

AUXILIARY EXPOSURE

A method used in the early days of photography in connection with slow plates to assist exposure. Before or after the proper exposure was made, extra exposures were given on coloured papers or through coloured glasses, as it was thought that by so doing more detail was obtained. In process work even to-day a piece of white paper is often placed for a few seconds in front of a photograph while it is being copied; while in France it is the custom with some expert operators with modern dry plates to expose for a second or so upon a piece of white paper before photographing dark interiors. It is doubtful if such auxiliary exposures are of any real use in these days of extra rapid plates, and there is always the risk of fogging. Auxiliary exposures have also been advocated for papers, particularly when harsh negatives are used, for the purpose of getting flatter, actually fogged, prints. When photographing gloomy interiors, the daylight is utilised as far as possible, and sometimes an auxiliary exposure with magnesium is given for the shadows.

AUXOMETER (Fr., *Auxomètre;* Ger., *Auxometer*)

An instrument for ascertaining the magnifying power of a lens or optical system.

AXIAL ACCOMMODATION OF THE EYE

In binocular vision, the converging or diverging of the axes of the eyes as required so that they meet where the object of attention is situated. The axis here referred to is the imaginary line drawn through the centre of the eye from the pupillary centre to the retina. In ordinary vision, the axes meet at the point where the object of immediate attention happens to be situated, and as the attention is turned from one object to another, the two eyes move by muscular control, simultaneously, so that whatever may be the position and distance of objects looked at, the axes converge or diverge as the case may require, bringing the attention of both eyes to a common point. When the object looked at is remotely placed, the eyes look almost parallel with each other; but if the object is only a few feet distant from the observer, a conspicuous convergence of the axes is noticeable. The constant change in the direction of the eyes' axes is known as axial accommodation, and without this double images would be seen and confusion of perception result. The term is sometimes applied to the adjustment of optical centres in binocular instruments, such, for instance, as the adjustment of twin lenses in a stereoscopic camera, binocular microscope, and so on. (*See* "Stereoscopic Photography.")

AZALINE (Fr. and Ger., *Azalin*)

A mixture of chinoline red and cyanine, introduced as a red sensitiser by H. W. Vogel, the use of which has been superseded by the newer isocyanines.

AZOL (Fr. and Ger., *Azol*)

A trade name for a concentrated one-solution developer whose action resembles that of rodinal. For plates and films 20 minims of azol are added to 1 oz. of water. For over-exposure 10 drops more of azol per 1 oz. of water are added, but for under-exposure the original quantity required is only 15 drops per 1 oz. For bromide papers the proportion is 15 drops of azol per 1 oz. of water, adding a few drops of a 10 per cent. solution of potassium bromide if the whites are not pure. Gaslight papers need 40 drops of azol per 1 oz. of water and potassium bromide as required; while for lantern slides the developer should be: Azol, 25 drops; bromide (10 per cent.), 5 drops; water to 1 oz.

AZOTATE

A term derived from the French and meaning nitrate.

AZOTE

A French term for nitrogen.

AZOTIC ACID

An Anglicised form of the French term for nitric acid.

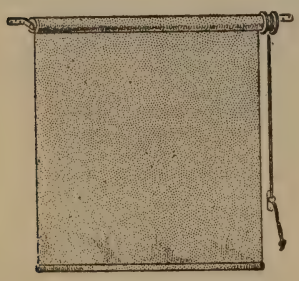
B

BACK FOCUS

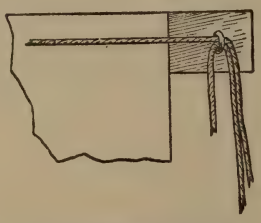
A term used to denote the distance between the back surface of a lens and the sensitive plate. It bears no fixed relation to the true focal length of the lens, and the old opticians inserted it in their catalogues only as a guide to the camera extension necessary. Many of the early cameras were sliding boxes, and would not close up enough to accommodate all lenses.

BACKGROUND (Fr., *Fond;* Ger., *Hintergrund*)

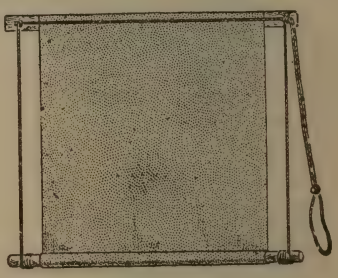
A term commonly applied to the painted sheets or screens used in studio portraiture; but actually the scenery, or anything else, whether natural or artificial, behind the sitter or object. Studio backgrounds are of many kinds, to suit different purposes and tastes; as, for example, vignette, full-length, interior, exterior, plain, graduated, and cloud backgrounds. They are usually painted in oil or distemper on canvas or stout paper, and are either attached to rollers or stretched tightly on a wooden frame having supporting feet. Backgrounds on rollers may be hung on brackets like blinds, as shown at A, with or without a spring roller, a pulley and cord being provided for raising and lowering. In another system B the background is fastened at the top to a horizontal lath, and is made to roll up or down from the bottom by cords passing through staples C, or over pulleys, on the same principle as theatre curtains are made to work.



A. Roller Background hung on Brackets



C. Background Cords passed through Staple



B. Background with Roller at Bottom

BACKGROUNDS, PRINTING-IN

The art of using two or more negatives to form one print has been widely practised for many years. It is sometimes referred to as double printing and as combination printing, but the former term is generally understood to mean the printing-in of clouds (*which see*), and the latter term (fully described under a separate heading) the art of combining in one picture pieces taken from a number of others. The printing-in of backgrounds differs from both of these. It is a common fact that many portraits are spoilt by ugly and unsuitable backgrounds, but it is possible to take out these and print-in more suitable ones.

The printing-in of backgrounds is easier with print-out papers than with development papers, such as bromide and carbon, where the progress of printing cannot be seen. The simplest method is first to block out the background on the original negative with an opaque mixture, going carefully round the outline of the figure with a finely-pointed camel-hair pencil charged with the pigment, which may be red water-colour. The broad expanse of background may be gone over with the pigment on the film side of the negative; or Brunswick black, or red or black paper, may be used on the glass side. It matters not how it is done so long as the background is covered up. In the illustrations, A represents a sitter against a brick wall which, being quite unsuitable, it is desired to take out. The blocked-out negative is printed in the usual way, and will give the result indicated at B—that is, the figure will have no background whatever. The print must not be toned or fixed yet. The selected background must next be printed in. To do this, carefully paint over the entire figure in print B, by gas or lamp-light, with red water-colour paint C, well covering the image and carefully following the outline. When quite dry place the print in contact with a suitable background negative and print in the usual way. The image will be printed upon the hitherto blank paper only, and the figure will be unaffected owing to the protection given by the red pigment (*see* D). Washing the print in water removes the paint and gives the result shown at F; this should be toned and fixed. Other prints may, of course, be made in the same way, but if a number is required it will save time to copy F in the camera and so obtain a new negative. If a good water-colour is used, the portrait image will not be injured in any way. If the work has been carefully done, no joins will be apparent. Any slight

overlapping may be touched out on the finished print.

Another method of printing-in backgrounds is first to block out the background, as in the previous case, so as to obtain result B. Print two of these. From one the figure is carefully cut out with scissors and laid face downwards on the background negative. (A print from it would resemble E, but this is not the result required.) The second print B is now laid on the prepared background negative in such a way that the printed figure is covered by the cut-out figure. The background is then printed in to give the result shown at F. A variation of the process is to print in the reverse way—that is, to make a print from the background negative (with the cut-out figure attached), so as to obtain a print like E, and to use this over the original negative with the background blocked out, so as to print in the figure B. Either method gives result F.

Both of the chief methods here described demand great care, and the first has the disadvantage that some little difficulty is experienced in getting the two separate printings to the same depth. By any of these methods, it is difficult to avoid false lighting of the figure.

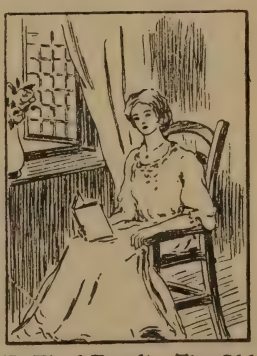
A. Print with Undesirable Background

B. Print with Background Blocked Out

C. Figure Painted Over with Water-colour

D. New Background printed-in; Figure Painted Over

E. Print from Background Negative, with Figure Blocked Out



F. Final Result. The Old Figure with the New Background

BACKINGS, PLATE

A backing is a coating upon the plain (glass) side of a dry plate in order to prevent reflections which cause halation. Plates may be obtained ready backed, many of the commercial backings being secret preparations and of excellent quality. Backings are of many kinds, more or less difficult to prepare, apply to, and remove from, the plate.

Liquid Backings.—Any red or black mixture will serve for ordinary plates, the latter being the more suitable for isochromatic or colour-sensitive plates. Such homely mixtures as red and black currant jam and shoe blacking have been advocated at various times, but there is no need to use such uncertain materials. Brunswick black is good for the purpose, but somewhat slow in drying. A quick-drying backing is a thin solution of bitumen in benzene, and this may be left upon the plate until after the negative is developed, fixed and dried, being then removed by the aid of benzene. As a general rule, backings should be removed before developing, because otherwise it is difficult to judge the progress of development and the density of the image. One of the commercial backings dissolves in the developer without affecting the working. Perhaps the best of the home-made backings is:—

Crystal caramel powder . .	1 oz.
Water	1 „
Methylated spirit . . .	½ „

The ingredients need to be mixed well together. Another formula is :—

Caramel	1 oz.
Powdered burnt sienna	1 ,,
Office gum	1 ,,

For isochromatic plates lampblack should be used instead of the sienna. J. S. Teape recommends the following :—

Caramel	1½ oz.
Saturated solution of gum tragacanth	1 oz.
Powdered burnt sienna	2 ,,
Methylated spirit	2 ,,

The spirit is added after the ingredients have been well mixed. The above are liquid backings, which are in optical contact with the glass.

Instead of caramel, it is possible to use various dyes and pigments, such as sienna, lampblack, etc. The following are typical formulæ :—

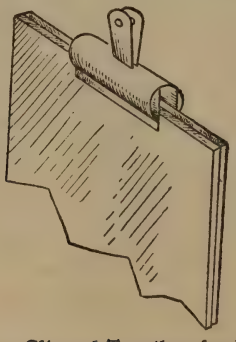
1.	Powdered burnt sienna	½ oz.
	Powdered gum arabic	½ ,,
	Glycerine	1 ,,
	Water	5 ,,
2.	Essence of cloves	6 parts
	Turpentine	7 ,,
	Lampblack	*q.s.*

to form a paste that may easily be distributed on the back of the dry plate.

3.	Methylated spirit	10 oz.
	Soap	200 grs.
	Erythrosin	1 drm.
	Aurin	1 ,,

Scrape the soap, and allow it to digest in the spirit for a week, shaking at intervals ; filter, and add the dyes. This gives a good yellow backing solution, which dries at once.

Paper Backings.—Backing sheets or papers are not so effective as liquid backings. Red or black paper is cut to size, one side smeared with glycerine, and pressed into close contact with the glass side of the plate. Special backing pads, which

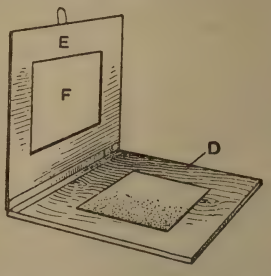


A. Plates Clipped Together for Backing

are preferable to the above, may be made by coating strong paper with the following mixture :—

Gelatine	1 oz.
Water	2 ,,
Glycerine	1 ,,
Indian ink, sufficient to colour.	

Dissolve by heating, and apply when warm to pieces of stout paper or calico, which require to be squeegeed on to the backs of the plates, and may be used over and over again if smeared occasionally with glycerine.



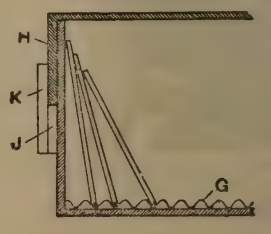
B. Plate-holder for Use in Backing

Comparisons.—The following table shows the effectiveness of the various backings, the test subject being severe :—

	Halation.
Unbacked plate	Very bad.
Plate backed with—	
Caramel and water	Very slight.
Bitumen	Very slight.
Sienna and water	Very slight.
Black paper and water	Bad.
Black paper and glycerine	Not so bad.
Shoe blacking	Slight.
Red and black currant jam	Slight.
Canada balsam and lampblack	Nil.
Caramel and sienna	Nil.

Films and lantern-slide plates are sometimes backed, but they do not show halation so badly as dry plates, and therefore the simplest backing will serve, if needed at all. (*See also* "Halation.")

Applying Backings.—The work of backing plates must be done in the dark-room, and varies somewhat with the nature of the material used. It is not absolutely necessary to wait until the backing is dry, although it is desirable to do so ; but if a plate is used with the backing still wet it should be covered with paper, preferably the oiled kind in which sensitive paper is sometimes wrapped. The backing must be applied evenly



C. Light-tight Drying Box

and not in streaks, and should cover every part of the plain glass side of the plate. The simplest method for small plates is carefully to put two plates film to film, and to clip them together at both ends as at A. The backing may then be applied by means of cotton wool or soft flannel (brushing causes streaks), and the plates then

hung up or laid aside to dry. In this way, and with ordinary care, the backing mixture is kept from the films.

For very messy backings the worker may prefer to use a holder as at B. In the centre of a piece of flat wood D, stout enough to prevent warping, is glued a piece of black velvet or other soft-surfaced material of the size of the dry plate. A piece of millboard or of thin wood E, of the same thickness as the dry plate and the same size as D, to which it is hinged, has at its centre a space F of the size of the plate, so that when the flap E is placed over the base D the velvet is seen through the hole. The plate is placed film side downwards upon the velvet, and E is brought into position over D, the back of the plate coming through F. The backing is spread over the plate, any superfluity going on to the card. The flap is then lifted up, and the plate removed.

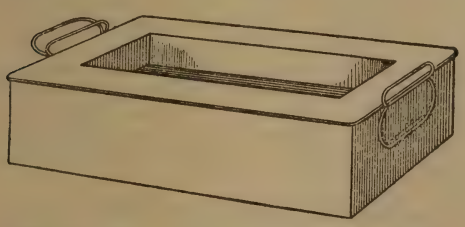
When using slow-drying backings, a dark box is convenient, and this can be made with a strong cardboard box 1 in. deeper than the longest side of the plates to be coated; the corners and joints should be covered inside with black paper so as to make the box light-tight. Place corrugated paper G or strips of cardboard along the bottom, as in illustration C, to prevent the plates from slipping. The first plate leans against the end of the box and supports the next one, a piece of red or black paper being interposed. The lid is made light-tight in the following manner: Under the edge of the lid H glue a strip J, and on J glue another strip K, covering over the edge of the lid of the box by an inch or more. When the lid is put on, the box will be quite light-tight, because of the light trap formed by J and K.

In process work, it is found that backing the plate gives greater freedom from grain between the lines or dots, and is quite worth the extra trouble. A good backing for this purpose is Lichtenstein's caramel with a little water and lampblack added.

BAG (*See* "Camera Bag," "Changing Bag," etc.)

BAIN-MARIE (Fr.)

A hot-water bath which in its simplest form is that of a jar in a saucepan of water, the gelatine, etc., to be dissolved or melted, being



Simple Type of Bain-marie or Water Bath

placed in the jar. The ordinary gluepot is an example of a bain-marie. The French cook has a utensil of the same style and name. A water bath of this kind (*see* illustration) is used by photo-lithographers for coating transfer paper.

BALAGNY'S DEVELOPER

An early form of pyro-ammonium carbonate developer for dry plates. The formula is:—

A. Ammon. carbonate	.	1¾ oz.	64·5 g.
Water	. .	35 ,,	1,000 ccs.
B. Pyrogallic acid	. .	1 ,,	28·4 ,,
Ammon. bromide		90 to 180 grs.	5·8 to 11·6 g.
Alcohol	. .	18 oz.	500 ccs.

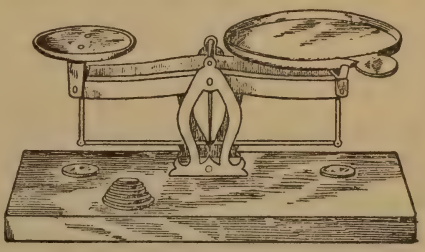
For use, mix 6 oz. of A with 1 to 2 drms. of B. Under-exposed plates are soaked first in A alone, and then in the mixture of the two.

More recently, Balagny has advocated an acid mixture of amidol. (*See* "Amidol.")

BALANCE IN COMPOSITION (*See* "Composition, Pictorial.")

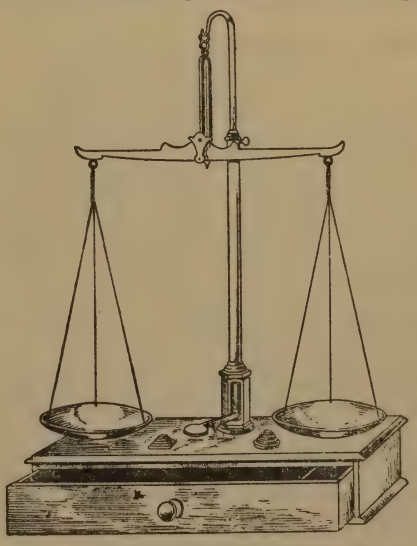
BALANCES (Fr., *Balances;* Ger., *Wagen*)

Weighing instruments. A high degree of



A. Scales

sensitiveness is not required in the photographer's balances; neither need the instruments be expensive. A pair of scales A, or a spring balance with pan to weigh up to about 4 oz. or ½ lb.,



B. Pharmacist's Balance

and a smaller balance B, of the kind used by pharmacists, will suffice for most photographic purposes. Glass pans, preferably removable, are best, as it is easier to keep them clean. A good balance should possess stability and

sensibility—that is, it should not oscillate long when the two pans are equalised, while a very trifling addition on either side should at once disturb the equilibrium.

BALLOON PHOTOGRAPHY (*See* "Aerial Photography.")

BALSAM (*See* "Canada Balsam.")

BALSAMO'S PROCESS (Fr., *Procédé Balsamo;* Ger., *Balsamo's Prozess*)

A printing process discovered by Prof. J. G. Balsamo, of Lucca, in 1861. Phosphorus is digested for a considerable time in hydrochloric acid at the ordinary temperature, or, to hasten matters, at a temperature of about 120° to 140° F. (about 49° to 60° C.). The solution improves by keeping. When saturated with phosphorus, the acid is diluted with copper acetate until the liquid assumes an olive green colour. Paper is immersed in this solution in a flat dish for three or four minutes, taking care that it is thoroughly impregnated, and is then thoroughly dried. The paper, which is very hygroscopic, is now exposed behind a negative, with a piece of blotting-paper at the back to absorb any moisture that may be disengaged, until the parts acted upon by the light become of a greyish colour, due to the production of copper binoxide. After removal from the frame, the print is exposed for about five minutes to the vapour of sulphuretted hydrogen, which converts the copper binoxide into copper sulphide. The print is next washed to remove the superfluous copper salts, and is then toned in a dilute solution of bismuth nitrate acidified with a little nitric acid, by which means bismuth is substituted for copper, thus rendering the print permanent.

BARIUM BROMIDE (Fr., *Bromure de baryum;* Ger., *Baryumbromid*)

$BaBr_2\ 2H_2O$. Molecular weight, 333. Solubilities $1\frac{1}{3}$ in 1 water, soluble in benzole. All barium salts are poisonous, and the antidotes are sodium or magnesium sulphates followed by emetics and the use of the stomach pump. Barium bromide is in the form of colourless crystals, which are prepared by dissolving barium carbonate in hydrobromic acid, evaporating and crystallising the solution. It is occasionally used in collodion.

BARIUM CHLORIDE (Fr., *Chlorure de baryum;* Ger., *Baryumchlorid*)

$BaCl_2\ 2H_2O$. Molecular weight, 244. Solubilities, 1 in 2·5 water, insoluble in alcohol. Poisonous (*see* "Barium Bromide"). It takes the form of colourless flat-sided crystals, which are prepared from barium carbonate and hydrochloric acid. It is occasionally used in emulsion making, but chiefly in the preparation of barium sulphate.

BARIUM IODIDE (Fr., *Iodure de baryum;* Ger., *Iodbaryum*)

$BaI_2\ 2H_2O$. Molecular weight, 427. Solubilities, 1 in 0·5 water, 1 in 20 alcohol. It is poisonous; for the antidote, *see* under heading "Barium Bromide." It is in the form of colourless crystals, obtained by decomposing ferric iodide with barium hydroxide. It is readily decomposed on exposure to the air, giving off free iodine. Occasionally it is used in making collodion emulsion.

BARIUM MONOXIDE, OR BARYTA (Fr., *Monoxyde de baryum;* Ger., *Baryummonoxyd*)

BaO. Molecular weight, 153. A grey, porous mass, fusing at a high temperature. It is prepared by decomposing barium nitrate by heat, and is (or was) used in Brin's process for the manufacture of oxygen—the method employed in extracting the oxygen for compression into cylinders as used by lanternists.

BARIUM NITRATE (Fr., *Azotate de baryum;* Ger., *Baryumnitrat*)

$Ba(NO_3)_2$. Molecular weight, 261. Solubilities, 1 in 12 water, insoluble in alcohol. It is poisonous; for the antidotes, *see* under heading "Barium Bromide." It is occasionally used as an admixture in magnesium flashlight powder and for making barium monoxide.

BARIUM PEROXIDE (Fr., *Bioxyde de baryum;* Ger., *Baryumperoxyd*)

Synonyms, barium dioxide or superoxide. BaO_2. Molecular weight, 169. Solubilities, insoluble in water, soluble in dilute acids with decomposition. A heavy, greyish-white powder, obtained by heating barium nitrate. It has been suggested for dissolving the silver image so as to obtain reversal, its action being due to the formation of nascent oxygen. It also occurs in a hydrated form, $Ba(OH)_2\ 8H_2O$, having the molecular weight, 315, and being slightly soluble in water.

BARIUM SACCHARATE (Fr., *Sucrate de baryum;* Ger., *Zuckerbaryt*)

Soluble in water. It is poisonous; for the antidotes, *see* under heading "Barium Bromide." It occurs in white crystals, but a solution was suggested by Mathet as a substitute for the alkalis in developers. Excess of barium hydrate is shaken for several days with a 10 per cent. solution of sugar and then filtered; but it has found no practical use.

BARIUM SULPHATE (Fr., *Sulfate de baryum;* Ger., *Schwefelsaures baryt, Schwerspat*)

Synonyms, barytes, synthetic barytes, blanc fixé, permanent white, baryta white, mountain snow. $BaSO_4$. Molecular weight, 233. Solubilities, insoluble in water and alcohol. It is a heavy, white, impalpable powder, occurring naturally or prepared by adding sulphuric acid or a soluble sulphate to a soluble barium salt. It is used to prepare baryta paper (*which see*), the very commonly used paper for silver printing processes.

BAROMETER, PHOTOGRAPHIC

Photographic prints that act as weather indicators; known also as weather-glass prints. Certain coloured photographs will alter with the varying atmospheric conditions, owing to the fact that cobalt chloride ($CoCl_2$) has been used in preparing them, this salt being blue when anhydrous (perfectly dry) and pink when

damp. Cobalt solutions may be used as sympathetic inks, the writing being almost invisible until warmed before a fire and all moisture driven out, when it becomes blue. A finished but unmounted bromide print is soaked for ten minutes in a 5 per cent. solution of formaline, and then is washed and dried. The cobalt solution is made as follows:—

Gelatine . . .	¼ oz.	68 g.
Glycerine . . .	1 „	250 ccs.
Cobalt chloride . .	40 grs.	23 g.
Water . . .	4 oz.	1,000 ccs.

The gelatine (ordinary cooking gelatine will serve) is soaked in the water until swollen, and is then melted by gentle heat; then the glycerine is added and next the cobalt chloride. The warm solution is brushed over the bromide print that has been previously treated with the formaline. The print is drained, dried, and hung up unframed or in an unglazed frame. The print is of a pinkish colour in wet weather, blue in dry and fine weather, and of a lilac or lavender colour in changeable weather.

BARYTA (*See* "Barium Monoxide.")

BARYTA PAPER (Fr., *Papier baryté;* Ger. *Barytpapier, Kreidepapier*)

Good raw paper stock coated with an insoluble emulsion of baryta in gelatine and used principally for coating paper intended to take a gelatino-chloride emulsion. A good baryta paper must be coated with three films, the first two serving to prevent the emulsion from coming into contact with the paper and the third giving the particular surface and tint desired. Both glazed and matt surfaces, tinted red, blue or violet, or white, can be obtained. It is also used in surfacing paper for collotype and Woodburytype.

Its preparation requires costly machinery. The baryta is either precipitated by the paper coater, or bought in the form of powder and mixed in a kneading machine with one-third its weight of water till a perfectly uniform cream is obtained, which is carefully sifted, divided into two equal parts, and thoroughly mixed with gelatine solution. To one part of the baryta emulsion is slowly added, with constant stirring, a solution of chrome alum, which causes the emulsion to become ropy, and at the moment of this appearance the other half of the baryta emulsion is added. The mixture is again passed through sieves, some glycerine added, and then coated on the paper. The first coating is so adjusted that there is about 12 to 15 g. of dry baryta to every square meter (17 to 21 grs. per square foot). The emulsion is picked up by the paper, which is coated in long rolls, by passing through a trough, or it is wiped on by a roller, and it then passes over a rubber-coated cylinder; evenness of coating is obtained by seven brushes with reciprocating motion, the first being hard and the others gradually increasing in softness until the seventh is of the very finest and softest badger hair, about 2 in. long. The paper is then hung in festoons to dry, rolled up, and given the second coating in precisely the same way. Sometimes it is then calendered, but usually again coated by the same machine with another baryta emulsion containing glycerine and chrome alum, and more or less gelatine, according to the surface desired. To this emulsion is also added the colouring matter—Paris blue, ammoniacal carmine solution, etc., being used. After drying, the paper is passed through calendering machines, which are provided with heavy steel rollers, which may, or may not, be heated, and exert a pressure of about 10,000 lb. The paper is sprayed with water before passing through the calender rolls, and the surfaces of the latter are highly polished, roughened, or grained respectively, so as to impart a special surface to the baryta film.

The commercial baryta paper is usually obtainable in rolls of about 600 metres in length, and is graded according to surface—matt, glossy, rough or grained—and according to the weight in grammes per square meter.

BASEBOARD (Fr., *Base;* Ger., *Bodenbrett*)

The board serving as the foundation of any apparatus, particularly of a camera. Except in studio and process cameras, it is generally hinged to the body, in order to fold up; and it is provided with a bush to take the screw attaching the camera to the tripod stand, or with a circular turntable, which can be fitted on the legs of the latter. The stability of the baseboard is a vital consideration for serious work, especially that of a scientific or technical nature, and for such the studio pattern of camera is preferable, where it may be used.

BASKETT'S REDUCER

A mechanical abrading reducer for negatives and lantern slides, introduced by Robert Baskett in 1901; known also as the Globe polish reducer. The formula is:—

Terebene	2 oz.
Salad oil	2 „
Globe metal polish . .	One 2d. tin.

The terebene is sold at oil and colour shops as a paint drier at about eightpence per pint; the refined spirit, costing about one shilling per ounce, is not required. The ingredients are well mixed together and strained once or twice through fine muslin into a bottle. When required for use, shake up the mixture, put a few drops on a piece of cotton wool or chamois leather, and rub gently and evenly over the parts of the negative (which must be perfectly dry) to be reduced. Rub with a circular motion and not too hard, as it is easy to rub a hole in the film. When the surface reduction has proceeded far enough and the surplus grease has been wiped off with a piece of clean cotton wool, a final rubbing with a pad slightly moistened with benzene will give a polished and nearly waterproof surface that is with difficulty distinguished from the glass side of the negative. Alcohol will also clean off the superfluous reducer. The reducer is particularly suitable for local reduction when only a part of a negative and not the whole is to be reduced. Some kinds of liquid metal polishes, which are put up in convenient metal bottles, can be used as reducers exactly as bought.

Alcohol used in the same way as this reducer acts similarly, but takes very much longer.

BAS-RELIEFS

Plaster or wax casts in low relief produced from photographs; formerly they were popular for brooches, cameos, etc. Generally, the relief obtained is very small. The process depends primarily upon the hardening action of light upon gelatine impregnated with potassium bichromate. A negative should be specially taken for the purpose of the first experiments, a suitable subject being a modelled bust or a sculptured bas-relief. Landscapes are practically impossible subjects; while portraits should not be attempted unless the sitter's face and hair have been powdered to imitate a bust, great care has been taken with the lighting, and the photograph has been taken in the brightest possible light against a perfectly black background. Any heads attempted should not exceed 3 in. in height, as the relief obtained is not sufficiently strong for larger sizes. Success depends upon the contrasts in the negative, and if not sufficient these should be increased by local intensification or by working on the back of the negative.

Having obtained a suitable negative, a sheet of No. 4 gelatine is soaked in a solution of 1 drm. of potassium bichromate in 6 oz. of water. The swollen gelatine is next squeegeed on to a well-waxed glass plate and dried slowly in the dark, it being then stripped from the glass and its polished side printed upon from the negative.

An alternative method of preparing the bichromated gelatine is to soak 5 oz. of gelatine (Nelson's No. 1) and 2 oz. of powdered gum arabic for four hours in a mixture of 6½ oz. of acetic acid and 18½ oz. of water; at the end of the four hours dissolve by gentle heat, strain through clean linen, and coat some polished glass plates with it, avoiding air-bubbles and dust. Dry the plates in a well-ventilated dark-room as rapidly as possible, maintaining the temperature at from 50° to 75° F. (10° to 24° C.).

Either gelatine sheet or plate is printed by daylight in contact with the special black and white negative. Exposure depends upon the strength of light and density of the negative, the average duration being thirty minutes. The gelatine shows a faint image, which is a slight guide.

The gelatine sheet, after printing, is cemented firmly, face upwards, to a piece of glass, by means of liquid glue or similar adhesive, and the whole is then soaked in cold water for several hours, at the end of which time the parts acted upon by light are found to have lost their power of absorbing water, while the other parts swell considerably. If the relief is not sufficiently pronounced, it may be increased by soaking in a solution of 1 oz. of citric acid in 4 oz. of water and transferring to water. When swelled as much as possible the superfluous water is drained and removed with blotting-paper, some oil poured on and drained off, and it is then ready for casting from.

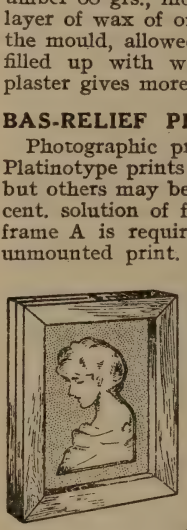
In the case of a glass plate instead of the gelatine sheet, after printing it is soaked in a solution of 2 oz. of powdered alum and 30 drops of glacial acetic acid in 40 oz. of water. At the end of two hours a fairly good relief should be secured. If the relief is not enough the negative may have been unsuitable, the exposure under the negative not long enough, or the plate dried too slowly after sensitising. The superfluous moisture is blotted off and the relief oiled.

Whichever method has been employed, the result so far is an oiled gelatine mould, from which a cast is now to be made in plaster-of-paris or wax. The mould is placed in an old printing frame or a tray; or, instead, wooden sides are built up round it to form a receptacle for the plaster. All surfaces which the plaster will touch, except the relief itself, should now be smeared with vaseline. Mix up some perfectly fresh plaster-of-paris to about the consistency of cream, immediately strain through muslin, and without losing time pour on to the oiled relief to a depth of ½ in. When the plaster has set it may be separated from the relief and the latter used again after soaking in water and oiling.

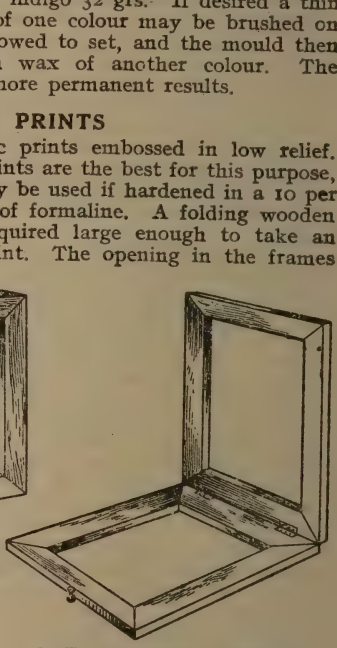
In addition to plaster, stearine, spermaceti, and even heavy brown wax, make excellent casts. Coloured waxes may be made according to the following formulæ (given by H. E. Blackburn): *Red.*—Wax 500 grs., India red 64 grs., carmine lake 90 grs. *Sepia.*—Wax 500 grs., sepia 50 grs., lampblack 10 grs. *Green.*—Wax 500 grs., cobalt blue 10 grs., Indian ink 50 grs. *Blue.*—Wax 500 grs., Frankfort blue 100 grs., alizarin blue 15 grs., Indian ink 50 grs. *Warm black.*—Wax 500 grs., lampblack 50 grs., burnt umber 60 grs., indigo 32 grs. If desired a thin layer of wax of one colour may be brushed on the mould, allowed to set, and the mould then filled up with wax of another colour. The plaster gives more permanent results.

BAS-RELIEF PRINTS

Photographic prints embossed in low relief. Platinotype prints are the best for this purpose, but others may be used if hardened in a 10 per cent. solution of formaline. A folding wooden frame A is required large enough to take an unmounted print. The opening in the frames



B. Bas-relief Print in Folding Frame



A. Folding Frame used in making Bas-relief Prints

must be as large as the actual portrait, but smaller than the complete print. Profile portraits give the best results. On a piece of cardboard the same size as the print, is traced the outline of the head and bust; to do this, trace the head on a piece of tracing paper and transfer to the cardboard by means of carbon (manifolding) paper. Cut out the space inside the outline,

and the card will then form a mask, which should exactly correspond with the outline of the portrait. The print is now mounted on thick blotting-paper with starch or other slow-drying adhesive, and is placed under heavy pressure for ten or fifteen minutes, after which time it should feel damp and pliant. Some workers wet the blotting-paper to ensure this. The cut-out mask is next placed over the face of the print in register, and the whole put into the frame and clamped. The arrangement is shown by B, the bust being seen through the hole in the card. By means of a bone or ivory paper-knife, or the handle of a tooth-brush, carefully apply pressure from the blotting-paper side and raise or emboss those parts desired, holding the frame in the left hand and working with the right, the face of the print being nearest the operator. First of all work the tool all over the back of the portrait with a circling motion, and then apply more pressure to the nose, cheeks, dress, etc., which need to be given in prominence. The work must be done very gently, as the blotting-paper is damp, and the tool may go through the picture and spoil it. Leave in the frame until dry and mount on stiff card by the edges only. (For imitation bas-reliefs, *see* "Plastic Photographs.")

BATHS (Fr., *Bains ;* Ger., *Bäder*)

A name given both to the trays, dishes, or troughs holding photographic solutions, and to the solutions themselves. Thus, the dish used in fixing is known as the "fixing bath," a term also applied to the "hypo" solution which it contains. Baths may be either upright (as, for example, the silver bath in the wet collodion process), or horizontal (as, for example, the dishes or trays for developing, toning, and fixing). Dishes and trays are made in many different materials, such as porcelain, stoneware, "granitine," glass, enamelled iron and steel, papier mâché, vulcanite, celluloid, zinc, lead, etc. Glass dishes and dishes coated with vitreous enamel have the advantage that they are unaffected by chemicals, readily cleaned, and show distinctly any lack of cleanliness. But porcelain dishes are commonly preferred for most purposes, although they will not resist all chemicals. For developing, ebonite or celluloid dishes are probably most convenient; for toning and fixing, porcelain or glass; while enamelled iron or steel is used for hot-bath platinotype. Lead or stoneware troughs and trays are employed to resist acids.

BAUDRAN'S COLOUR PROJECTION METHOD

A method of projecting ordinary uncoloured photographic prints on to a surface whereon they are said to appear more or less coloured. It was invented by Baudran, of Versailles, in 1891. It is well known that some daguerreotype pictures show a trace of natural colour when viewed at a certain angle, and Baudran thought that by properly lighting ordinary pictures on silver paper he could obtain colours in the same way. An opening is made in the shutter of a dark-room, and on a shelf outside is placed a photograph, preferably an enamelled print on albumen paper, facing the opening and cutting off much of the light that would otherwise be admitted. A mirror is so placed as to reflect light upon the photograph, the object being to light the image in the same way as the original subject was lighted. In the opening in the shutter is placed a camera which projects an enlarged image on a screen inside the dark-room. The image is said to be coloured. All colours do not appear equally well, but that of the flesh is said to be visible mostly always, although not very bright.

BEACH'S DEVELOPER

A pyro-potash developer popular at one time, particularly in the United States, where it was originally introduced by F. C. Beach. It gives a clear negative and a fine black image, which was considered preferable to the yellowish, slow-printing negatives produced by the pyro-ammonia developer. The inventor appears to have modified his developer a number of times, but the chief ingredients were always pyrogallic acid, sodium sulphite, acid and potash. The best way to make up the two stock solutions is described below, the actual formula being :—

No. 1 (pyro solution)—		
Water . . .	5 oz.	142 ccs.
Sodium sulphite .	4 ,,	124 g.
Sulphurous acid .	4 ,,	124 ,,
Pyrogallic acid .	1 ,,	28·4 ccs.
No. 2 (potash solution)—		
Potassium carbonate	3 oz.	93 g.
Sodium sulphite .	2 ,,	62 ,,
Hot water to .	10 ,,	284 ccs.

For the pyro solution the water is boiled and the sodium sulphite dissolved therein. When cold the sulphurous acid (dilute, as sold by chemists) needs to be added, and finally the pyro. Beach's original method of making the potash solution was to dissolve the carbonate in 4½ oz. of hot water, the sulphite in 4 oz. of hot water, and to mix the two. The above are stock solutions, which will keep good for a long time. To make a working developer, take 1 oz. of water, add to it 1 drm. (60 minims) of the potash (No. 2) solution, and from 20 to 30 drops of the pyro (No. 1) solution. Add bromide in cases of over-exposure.

BEAUMÉ DEGREES (*See* "Hydrometer.")

BECQUEREL RAYS

Very shortly after the discovery of the Röntgen rays, H. Becquerel discovered that the metal uranium, its earths and compounds, emitted rays which penetrated wood, glass, and even some metals, and exerted an action on a dry plate similar to that of light. He proved that the richer an earth or compound was in uranium the stronger were the rays emitted, and this led to an examination of pitchblende by M. and Mme. Curie, who finally isolated radium from the uranium pitchblende and proved that to this were due the Becquerel rays.

BEDFORD, FRANCIS

Francis Bedford (*b.* 1816, *d.* 1894) was associated with photography since its first practical inception, and had such skill as a landscape worker that he was invited to form one of the

party selected to accompany the late King Edward (then Prince of Wales) when he visited the East in 1863. His son William (*b.* 1847, *d.* 1893) was President of the Bath Convention, 1891.

BEECHEY'S DRY PLATE (EMULSION) PROCESS

A method of preparing collodion dry plates, published by the Rev. Canon Beechey in October, 1875, further details appearing in 1879. The plates were coated with a collodion made according to the following directions: First prepare a solution of cadmium bromide 32 grs., alcohol 1 oz. Decant after standing for some time, and add hydrochloric acid 8 minims. Next take above solution ½ oz., absolute ether 1½ oz., pyroxyline 12 grs. The plates having been coated with this are next sensitised in an alcoholic silver nitrate bath (40 grs. to the ounce), the plates being previously given a substratum of gelatine or indiarubber. They are then soaked in a solution of 20 grs. of pyrogallic acid in 20 oz. of flat bitter beer, which acts as a preservative. Great latitude is allowable in the exposure, from thirty seconds to five minutes being common. The following developer was specially recommended:—

Potassium bromide (12 grs. per 1 oz. solution) . . .	15 drops
Pyrogallic acid (96 grs. solution)	30 „
Ammonium carbonate (60 grs. solution)	3 drms.

The plates were an article of commerce for many years, and were very popular for transparency work.

BEER DRY PLATES

Dry collodion plates at one time used chiefly for positive (lantern-slide) work. The plates were sensitised in the usual way, washed, coated with beer, and dried. Further information will be found under the following headings: "Albumen Process," "Beechey's Dry Plate (Emulsion) Process," and "Coffee Process." The beer, coffee, etc., acted as preservatives.

BEESWAX (Fr., *Cire*; Ger., *Bienenwachs*)

A wax obtained from the honeycomb of the bee. Melts at 62° to 65° F. It is insoluble in water and alcohol, but, if pure, entirely soluble in hot oil of turpentine. The wax when pure is a yellowish mass of a pleasing smell, and breaks with a granular structure. It is used in some processes of carbon printing. White wax should be ordinary beeswax bleached by exposure to sunlight and air.

In process work, beeswax forms an important ingredient in the composition of etching inks. A dusting-on powder, known as waxed asphaltum, for photo-lithographic half-tone transfers, consists of beeswax and asphaltum melted together and powdered. Beeswax (preferably the best Gambia) is largely used in electrotyping, for making the moulds from blocks or type.

BELITSKI'S REDUCER

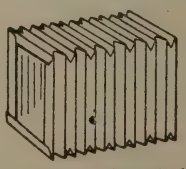
A one-solution reducer for negatives, known also as the "green" reducer. The formula is:—

Potassium ferric oxalate .	150 grs.
Sodium sulphite . . .	125 „
Water	7 oz.

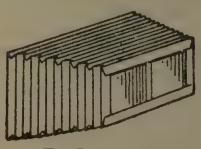
Shake until dissolved, and add oxalic acid 40 to 45 grs. Shake again until the solution turns green, pour off the solution from any undissolved crystals, and add hypo 1¾ oz. Instead of the potassium ferric oxalate, which is at times difficult to obtain, 100 grs. of ferric chloride crystals and 190 grs. of potassium oxalate may be used. The reducer is usable over and over again, does not stain, and keeps well in the dark.

BELLOWS (Fr., *Soufflet*; Ger., *Balg*)

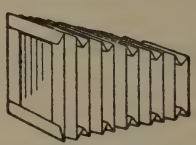
The light-tight, collapsible, or expanding connection between the back and front of the camera, usually made of leather or American cloth lined with black fabric. There are various shapes, as, for example, square A, oblong, conical (or, more correctly, pyramidal) C, stereoscopic B, truncated-cornered D, and others. The square bellows is generally preferred for studio, process, and scientific apparatus. The lighter and handsomer pyramidal bellows, now



A. Square, Parallel Bellows



B. Stereoscopic Bellows with Division



C. Conical or Pyramidal Bellows

D. Bellows with Truncated Corners

almost universally seen on field and hand cameras, may sometimes cut off a part of the view when using the rising front, unless care is taken. The oblong bellows is practically out of date, except for stereoscopic cameras, owing to the introduction of the reversing back. The stereoscopic bellows, which may be either oblong or pyramidal, is provided with a central partition folding in unison with the bellows. A bellows with truncated corners has the advantages that it closes in smaller space, is more elastic, and the folds are less liable to cling together.

BENNETT'S CARBON SENSITISER

A solution for sensitising the carbon tissue supplied in an insensitive condition; introduced by H. W. Bennett. The formula is:—

Potassium bichromate .	4 drms.	22 g
Citric acid . . .	1 drm.	5·5 „
Strong ammonia (about)	3 drms.	16·5 „
Water . . .	25 oz.	1,000 ccs.

The proportion of water may be varied, any quantity from 10 oz. to 25 oz. being used; the smaller quantity of water makes the tissue more

rapid, but it gives less contrast in the print, and the full quantity is better for ordinary work. The quantity of ammonia is only approximate; it must be determined by the amount necessary to change the colour of the solution from the deep orange of the bichromate to a distinct lemon yellow. To sensitise, the piece of tissue should be immersed in the solution for two minutes, withdrawn, laid on a piece of glass or ferrotype, squeegeed to remove as much of the solution as possible, and then lifted from the glass and pinned to a lath by two corners, or suspended from a cord by clips, so as to hang freely exposed to the air to dry. Drying should be accomplished in from four to six hours. Sensitising may be done in full daylight, but drying must take place in the dark.

Tissue sensitised in this solution will render gradation much more perfectly, especially in the lighter tones. A little gaslight in the drying-room will have no effect on the quality or solubility of the tissue; even a considerable amount of gaslight will be practically negligible. Details of working are given under the heading "Carbon Process."

BENNETT'S REDUCER

A well-known reducer, introduced by H. W. Bennett, made by adding sodium sulphite to a solution of ammonium persulphate, and acidifying by means of sulphuric acid. Reducing by means of this reagent is reliable and uniform in its results; the operation is free from the risk of staining and other irregularities which previously made the ammonium persulphate reducer uncertain. The formula is:—

Ammonium persulphate	1 oz.	118 g.
Sodium sulphite . .	85 grs.	21 ,,
Sulphuric acid . .	45 mins.	10 ccs.
Water to make . .	9¼ oz.	1,000 ,,

(For working details, *see* "Reducing Negatives by Chemical Means.")

BENNETT'S TONING BATH FOR P.O.P.

A combined toning and fixing bath that gives rich purple tones on most brands of P.O.P., introduced in 1908 by H. W. Bennett. It contains a sufficiently large proportion of "hypo" to ensure perfect fixation of the prints, and the bath is rendered slightly alkaline with ammonia. Prints toned and fixed in this bath are as permanent as any silver prints; they preserve their original richness and freshness unimpaired for many years. A feature of the bath is the fact that separate solutions are kept of each ingredient, and they are so adjusted that equal quantities of each are taken, excepting the "hypo" solution, and 1 oz. of that is required for each dram of the others. No calculation is needed, whatever quantity of solution may be required. Five solutions are necessary:—

A.	Sodium hyposulphite . .	1 lb.
	Water, sufficient to make .	32 oz.

The "hypo" should be dissolved in boiling water.

B.	Ammonium sulphocyanide .	2 oz.
	Water to make . . .	8¼ ,,
C.	Lead acetate . . .	1 ,,
	Boiling water to make .	8¼ ,,

A dense precipitate will settle. The bottle must be well shaken each time any solution is required.

D.	Gold chloride . . .	15 grs.
	Water . . .	2 oz. 7 drms.
E.	Strong ammonia . .	120 mins.
	Water to	10 oz.

Each solution will keep indefinitely. To prepare the bath, mix together in the order given: 1 oz. of A, 1 drm. of B, 1 drm. of C, 2 oz. water, 1 drm. of D, and 1 drm. of E. The measure must be thoroughly rinsed after measuring C and D. The solution is ready for use in five minutes. This quantity is sufficient for ten quarter-plate prints; a suitable quantity for any other number may be prepared by allowing ½ oz. of A for every five quarter-plate prints, and remembering that whatever number of ounces of A solution are taken, the same number of drams of each of the others will be required. The prints are immersed in the bath without previous washing, and they should be put in the solution one at a time, and each one thoroughly wetted before the next is added. All the prints that are to be toned in one dish should, however, be put into the solution as quickly as possible consistently with covering each with the solution evenly.

As soon as the last print is placed in the dish the first should be taken from the bottom, brought to the top, and quickly examined. Should any air-bells have formed on the surface they will show as dark marks; but if they are broken at once with the finger they will not show on the finished print. The second print that was placed in the bath will now be the lowest; this should be brought to the top, and so on with each print in turn, until all have been changed in position. Throughout the operation the same method of procedure must be followed—the lowest print brought to the top; but after the first changing the work should proceed more leisurely, leaving each print a longer time at the top of the solution. The minimum time of immersion in the bath is twelve minutes in hot weather if the temperature of the solution is 70° F. (21° C.) or more, and fifteen minutes in cool weather, though the toning should not be done in a room at a lower temperature than about 60° F. (15·5° C.). This minimum time is very important; if less time in the solution is given, imperfect fixing will result. Longer time may be allowed if cooler tones are desired; twenty minutes will not be too long. If warmer tones are required, the composition of the bath must be varied, so that the desired tones are not reached before the prints are fixed. The amount of water used for making the B and C solutions may be increased to 11 oz., and for the D solution 3¾ oz., and the bath still prepared by taking 1 drm. of each for 1 oz. of A. As soon as the minimum time has elapsed, or the desired tone reached if longer than the minimum time, the prints are taken from the bath and at once well washed. If washed in water that is frequently changed, from one to two hours should be allowed, according to the frequency of the changes and the quantity of prints in one dish. Prints for this toning bath require to be very deep.

BENNETTO'S COLOUR PHOTOGRAPHY

A process of three-colour photography in which the three negatives were obtained at one exposure in a camera, the positives being made on red, yellow, and blue carbon tissues and superimposed. It has not been commercially introduced.

BENZENE (Fr., *Benzol, Benzine crystallisable;* Ger., *Benzol, Steinkohlenbenzin*)

Synonyms, benzol or benzole, coal tar naphtha, phenyl hydride. C_6H_6. Molecular weight, 78. Solubilities, insoluble in water, soluble in alcohol, ether, chloroform, acetone, and glacial acetic acid. The vapour is extremely inflammable. It is a colourless, mobile, volatile liquid, which can be obtained from benzoic acid, but is usually procured by distillation from coal-tar. It is used in varnishes and for developing in the bitumen process.

This substance must not be confounded with benzine or benzoline (*which see*). A crystal of iodine dropped into benzene turns carmine-coloured, whilst with benzine a violet colour is obtained. A drop or two of absolute alcohol will not mix with benzine, but mixes at once with benzene.

In process work, benzole is used for dissolving indiarubber to make the solution used in edging wet collodion negatives, and for coating the latter as a preliminary to applying collodion for stripping. It is the best solvent for asphaltum.

BENZINE (Fr., *Benzine*, Ger., *Benzin Petroleumbenzin*)

Synonyms, benzoline, petroleum ether, naphtha, petroleum naphtha; practically identical with petrol and gasolene. It is a colourless liquid obtained from petroleum by distillation. It is rarely used in photography, and must not be confounded with benzene (*which see*).

BENZOATE TONER

One of the many toners recommended in bygone days for plain salted paper. The following is a typical formula, and gives black-violet tones :—

Ammonium benzoate .	30 grs.	4·2 g.
Gold chloride . .	6 ,,	·8 ,,
Water	16 oz.	1,000 ccs.

BENZOIC ACID (Fr., *Acide benzoïque;* Ger., *Benzoesäure*)

Synonym, phenylformic acid. C_6H_5COOH. Molecular weight, 122. Solubilities, 1 in 15 boiling water, 1 in 1·8 alcohol; soluble also in ether, chloroform, glycerine, benzole, fixed and volatile oils. Borax or sodium phosphate increases the solubility in water. It occurs as white or faintly yellowish pearly plates or needles with agreeable aromatic odour and taste, and is obtained by sublimation from gum benzoin, or from toluene by oxidation with nitric acid, or from the urine of herbivorous animals by distillation.

BENZOLE (*See* "Benzene.")

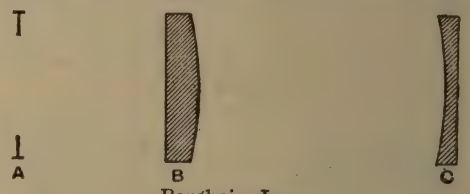
BENZOLINE (*See* "Benzine.")

BENZOQUINONE, OR QUINONE

$C_6H_4O_2$. Molecular weight, 108. Slightly soluble in water, more so in alcohol and ether. It forms volatile yellow prisms, plates, or needles, having a pungent smell. It is procured commercially by acting on aniline with a bichromate and sulphuric acid. It is used in the preparation of the developer hydroquinone (benzoquinol, or quinol, $C_6H_4(OH)_2$), a substance which is obtained by the reduction of quinone with sulphurous acid.

BERGHEIM LENS

This lens was constructed in 1896 by T. R. Dallmeyer at the suggestion of J. S. Bergheim, a painter, who wished for a lens which would give him correct drawing and soft definition without sacrificing the natural structure of the original. To obtain this end the inventor introduced a large amount of both spherical and chromatic aberration, so that to obtain the maximum sharpness possible with this lens an allowance has to be made after focusing. Although primarily intended for portraiture, the Bergheim lens is constructed on the telephoto principle, the front element B being a single uncorrected positive lens, while the back is an uncorrected negative lens C of similar focal length—that is to say, when the two lenses are brought into contact they neutralise each other, various focal lengths being obtained by separating them.



Bergheim Lens

The greater the separation the shorter is the resulting focal length. The diaphragm A is fixed in the hood of the lens, and is marked for apertures requiring certain fixed relative exposures, no matter what the temporary focal length may be. The characteristic feature of the definition given by this lens when skilfully used is a pleasing semi-sharpness through a very deep field, no actual sharpness or offensive fuzziness being visible.

BERKELEY'S SULPHO-PYROGALLOL

The first of the developing substances to be preserved in solution by means of an acidified sulphite; it was introduced by H. B. Berkeley, in 1882.

Berkeley's solution consists of 4 oz. of sodium sulphite with sufficient citric acid (about ¼ oz.) to render the solution distinctly acid; 1 oz. of pyro is dissolved in 9 oz. 55 minims of the solution, so that every 10 minims contain 1 gr. of pyro. The sulphite must be thoroughly dissolved in the water, and the solution acidified before the pyro is added. The introduction of sulphite as a preservative of pyro in solution has been of great service to photographers. The sulphite not only preserves the developing substance in solution, but prevents the rapid oxidation of the developer in use, thus keeping

the plate clean and free from stain. Without sulphite the use of pyro with the alkaline carbonates would be impracticable, on account of the very rapid discoloration of the developer and the excessive staining of the plate.

The use of an acidified solution of sodium sulphite as a preservative has been largely superseded in the case of pyro by the introduction of potassium metabisulphite, a strongly acid sulphite, though the sodium sulphite is still added to the developer to ensure clean working and freedom from staining. It is also used as a preservative for most of the more recently introduced developing reagents.

BICHROMATE

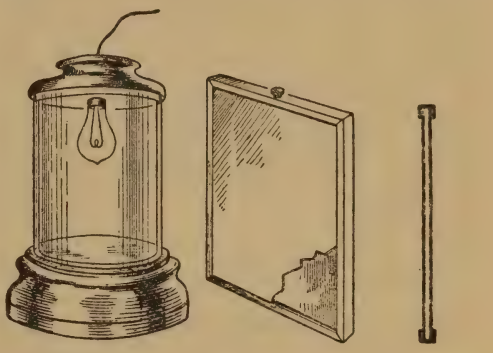
The bichromates commonly referred to in photographic literature are "Potassium Bichromate" and "Ammonium Bichromate" (*which see*).

BICHROMATE DISEASE

A skin disease that affects some workers who use potassium bichromate extensively. It occurs only when the skin is particularly sensitive and the hands are brought much into contact with the bichromate (dry or dissolved), and it takes the form of small ulcers or an irritating "rash." A preventive is to wear rubber gloves or fingerstalls. The hands should always be well washed in warm water after using bichromate, and wiped thoroughly dry. The use of a carbolic soap will often give relief from the itching, the hands being afterwards rubbed with a cooling ointment or the following mixture: Glycerine 4 drms., carbolic acid 1 drm., alcohol 5 oz. For very severe cases the following treatment has been advised: Rub into the skin a little nitrate of mercury ointment (obtainable from most chemists, and called by the Pharmacopœia "Unguentum hydrargyri nitratis"). (*See also* "Skin, Effects of Chemicals Upon.")

BICHROMATE LAMP

A lamp for dark-room use in which a solution of potassium bichromate serves as the light filter. Howard Farmer found that the various kinds of ruby and orange fabrics and glass in common use transmit only 2 per cent. or less of the light, whereas a 6 per cent. solution of potassium bichromate gives quite as much safety and gives more than 80 times the amount of illumination possible with orange glass. With other solutions the differences are still greater, but the potassium bichromate solution appears to be the best for general use. Most bichromate lamps are based on the pattern designed by Farmer, whose original lamp is shown at A. It consists of two concentric glass cylinders, about 4 in. and 5 in. in diameter respectively, placed one inside the other, mounted on a suitable solid base and furnished with a wooden cap, in which is mounted an incandescent electric bulb. This is excellent as a central light. A glass tank, for use with oil or gas lamps, is shown at B and C, such tanks being filled with a suitable solution and used in place of the usual red glass. As either type of lamp may be filled with any light-filtering solution, an opportunity is afforded of adapting the actinic quality of the light to particular requirements. A 6 per cent. solution of potassium bichromate is safe for bromide papers, but not for dry plates, especially isochromatic plates, a safe solution for which is made as follows: Dissolve 1 oz. of the bichromate in about 9 oz. of water. Take about 4 oz. of the solution, and add 1 drm. of



A. Bichromate Lamp B. Tank Light Filter C. Section of Tank Light Filter

eosine, which is a strong red dye, and gently heat until the colour is a deep red; mix the two solutions and pour into the lamp cell. Should the solution have a muddy appearance, pass it through filter paper.

BICHROMATE REDUCER

An acid solution of potassium bichromate may be used as a reducer for dense negatives in the same way as the more popular acid solution of potassium permanganate. A suitable formula is:—

Potassium bichromate	200 grs.	20 g.
Sulphuric acid . .	¼ oz.	1·2 ccs.
Water to . . .	20 „	1,000 „

Dissolve the bichromate in water, and add the acid. The solution keeps well, but is liable to be irregular in action.

BICHROMATED GELATINE

A term fully explained under the heading "Carbon Process." It refers to gelatine that has been sensitised with potassium bichromate.

BICONCAVE LENS

A lens, either simple or compound, of which both outer surfaces are concave. (*See also* "Lens.")

Biconcave Lens Biconvex Lens

BICONVEX LENS

A lens, either simple or compound, of which both outer surfaces are convex. (*See also* "Lens.")

BICYCLE (*See* "Cycle.")

BI-GUM PROCESS

A familiar designation for the "Gum-bichromate Process" (*which see*).

BINDERS

For lantern slides and transparencies, binders consist of narrow strips of gummed paper by means of which the plate bearing the image is secured to the plain glass which is placed over the film as a protection. They are made in two forms, short lengths sufficiently long for one edge of the lantern slide only, so that four binding strips are required for each slide, and long strips sufficiently long to bind all the four edges with one piece. The former are very much more easily applied.

BINOCULAR

Photographically, this is another name for "stereoscopic" (*which see*).

BINOCULAR MICROSCOPE

(*See* "Microscope.")

BIOGRAPH

A kinematographic instrument invented by Herman Casler, of Canastota, New York, U.S.A. In the early stages of kinematograph science the size of the film pictures was (as now) only 1 in. by $\frac{3}{4}$ in., and owing to optical and chemical limitations early results were unsatisfactory. Casler considered that improvements could be made if the film pictures were taken on a larger scale; and he proceeded to devise the biograph, in which he arranged to take pictures measuring $2\frac{3}{8}$ in. by $2\frac{1}{16}$ in. and to utilise the whole surface of the film, dispensing with side perforations, by the introduction of an arrangement of rollers, instead of sprocket wheels. Hence he presented his invention to the public in America during the autumn of 1896. The biograph projected pictures at the rate of thirty to forty per second, and flickering was thus largely overcome. Further, Casler, claimed that inasmuch as the film was carried forward by friction rollers instead of by sprocket teeth, there was greater steadiness of the images upon the screen. Against the advantages indicated must, however, be set the increased cost of production and the inconvenience of cumbersomeness in both the taking apparatus and the projecting machines. The biograph enjoyed a season of popularity in the United States and also in London; but it failed to become universal, whilst time has shown that small-size pictures and simpler apparatus could be improved to meet all requirements.

BIOSCOPE

A well-known type of kinematograph projector. The name is derived from two words signifying respectively *life* and *to see*, and was in use long before the introduction of the kinematograph, to which it was first applied by Charles Urban, at that time associated with the Warwick Company. The courts did not sustain the use of the word as a trade-mark.

BIRDS, PHOTOGRAPHY OF

Most of the methods used in the photography of animals (*see* "Animals, Photography of," "Zoological Photography," etc.) apply also in the case of birds. There are other points, however, to be taken into account. Many birds are not only small in size, but are difficult to approach because of their natural timidity and wildness, this being especially the case with birds in a free state. The telephoto lens becomes of increased value, even high magnifications having often to be employed. Even more than in the case of animals, it is necessary to possess considerable knowledge of the haunts and habits of birds, and frequently there must be added an unbounded store of patience and perseverance. It is frequently necessary to use all sorts of elaborate and ingenious appliances to bring the camera into workable proximity to the bird without alarming it and arousing its suspicions. In fact, no work of much value can be done in the direction of bird photography without making a special study of it and acquiring the necessary knowledge and apparatus to make good results possible. Particular attention should be paid to effective and characteristic pose, and natural surroundings, and the use of orthochromatic plates and suitable screens is often imperative to secure a true rendering of the colour values of the plumage.

BIS-TELAR

A telephoto lens of fixed magnification, introduced by Busch. It has a focal length of about $1\frac{3}{4}$ times the camera extension required, and the two kinds obtainable work at *f*/9 and *f*/7 respectively. It is well adapted for hand-camera work, and is largely used by press photographers when photographing distant objects.

BISULPHITE LYE

(*See* "Sodium Bisulphite.")

BITUMEN

(*See* "Asphaltum.")

BITUMEN OF JUDEA

(*See* "Asphaltum.")

BLACK CLOTH

(*See* "Focusing Cloth.")

BLACK, DEAD

Recipes for dead blacks are given under the heading "Blackening Apparatus."

BLACK LINE PROCESS

A name given to the original ferro-gallic, or Colas process, described under the heading "Ferro-gallic Process."

Another process known as "black line" is a printing process worked out in 1894 by R. Nakahara, of Tokyo. The sensitising solution is:—

Gum arabic . .	3 oz.	93 g.
Water . . .	22 ,,	625 ccs.
Tartaric acid .	192 grs.	12.5 g.
Common salt .	864 ,,	60 ,,
Ferric sulphate .	2 oz.	62 ,,
Ferric perchloride .	3 ,,	93 ,,

The gum is dissolved by heat in the water, and the other chemicals added to the warm solution. The solution is spread over well-sized paper with a sponge, and, after allowing it a little time to penetrate, all superfluous moisture is removed with the sponge well wrung out, and the paper dried as rapidly as possible. The exposure to daylight under a negative or plan is rather long. The colour of the prepared paper is yellow, but

during printing all but the lines turn to white. The print is developed in a plain aqueous solution of gallic acid, the strength of which is not important; the print must not be left too long in the developer or stains will result. The developed print is rapidly washed and dried. Success depends chiefly upon the sponging off of the superfluous sensitising solution and rapid drying.

BLACK MIRROR

A mirror formed of black glass and used for photographing clouds by reflection

BLACK OXIDE OF MANGANESE

(*See* "Manganese.")

BLACK, PROCESS

A black water-colour pigment largely used in retouching photographic prints with the aerograph and otherwise for process reproduction. It is claimed that it has no blue in its composition. It may be diluted with water for pure greys, or mixed with Albanine for the lighter shadows. It dries a dull black and reproduces well.

BLACK SPOTS

Black specks on negatives and prints, but more particularly upon ordinary P.O.P. Those upon the P.O.P. are caused (*a*) by metallic particles in the first washing water, these coming from a pump, tap, pipes, cistern, etc.; or (*b*) by trimming the untoned prints upon a metal plate. The spots cannot be removed, but they are easily prevented by immersing the prints before toning in a 10 per cent. solution of common salt, so as to convert all the soluble salts of silver into chloride, then washing again before toning. The addition of a little washing soda to the salt solution has also been recommended, the actual formula being 2 oz. of common salt and 1 oz. of washing soda to 1 pint of water. The prints are left in this for from five to ten minutes, then washed in running water for five minutes, and toned as usual. The above method serves to prevent spots, but when platinum is used as a toner instead of gold, the washing soda should not be used, only the plain salt and water.

Black specks upon negatives and developed prints (bromide and gaslight papers) are caused by undissolved particles of the developer proper, hydroquinone, amidol, etc., settling upon the film. These particles may be present undissolved in a freshly made developer, or may be flying about the room and settling upon the sensitive surface in the form of dust.

BLACK TONES

Black tones are obtainable upon carbon and other pigment papers, which already have a base of black pigment, platinotype, bromide, and gaslight papers with ease, and on print-out papers with difficulty. The richness and quality of the blacks on platinotype are characteristic of the process and depend upon the state of the paper, exposure, etc. The quality of the blacks upon bromide and gaslight papers depends upon the exactness of exposure and upon the state of the developer, because if too much potassium bromide is used in the latter the blacks are greenish in tone, and if too little is used neither the blacks nor the whites are of the best.

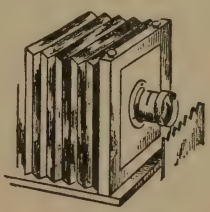
All tones upon P.O.P. largely depend upon the quality of the negative; and for black tones the negative should preferably be rather hard—that is, should have dense high lights and clear shadows. Such a negative should be printed under green glass and toned in any gold or platinum bath, or in the following combined toning and fixing bath:— A. "Hypo" 4 oz.; water 10 oz. B. Lead nitrate 1 oz.; distilled water 10 oz.; glacial acetic acid 48 drops. Add B to A gradually, and with shaking, until a distinct cloudiness appears; then filter. Take 10 oz. of the above mixture and add 1 grain of gold chloride, and this forms the toning bath. If black tones do not result, the negative was not suitable, or the printing has not been suitably carried out. Some workers obtain a rich black tone on P.O.P. by using gold first and platinum afterwards, but, as in all cases, much depends upon the suitability of the negative.

BLACK VARNISH

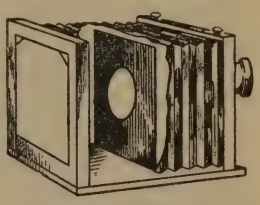
(*See* "Varnish.")

BLACK VIGNETTES

A style of portrait known also as "Magic," "Egyptian," and "Russian" vignettes, invented in 1868 by a Russian photographer named Bergamaso. The sitter's head is made to stand out against a perfectly black background, the edges of the picture all round being black instead of white as in an ordinary vignetted



A. Black Vignetting with Serrated Card in front of Lens



B. Black Vignetting with Card inside the Camera

portrait. The sitter is placed against a perfectly black background, and the light is prevented from acting on the edges of the plate, more particularly on the lower part (upper part as it is seen on the focusing screen). The light is cut off from the plate either by means of a serrated piece of blackened card or tinplate on an adjustable rod outside the camera, and before the lens, as A, or by the insertion of a black card with an opening in the centre, in the bellows of the camera, as B. Either system, when properly used, cuts off the light at the top or bottom and gives a negative with plain glass borders which print black, the well-lighted head appearing in the centre.

BLACKENING APPARATUS

Only a dead black is suitable for the interior of a camera, as a glossy black would give rise to reflections.

Blackings should be tested upon pieces of metal, wood, leather, etc., before applying to the apparatus. Recipes are as follow:

Brasswork.—To blacken camera brasswork, clean with fine emery, rinse, and immerse in a saturated solution of copper nitrate for about two minutes. Then take out, heat over a Bunsen burner or ordinary spirit flame, and repeat the process several times. To make the copper nitrate, dissolve 1 oz. of copper filings in 2 oz. of nitric acid; do this in the open air, and stir with a glass rod to assist dissolving.

Zincwork.—Clean and rinse as before, and immerse in a solution of copper chloride 45 grs., zinc nitrate 30 grs., and water 4 oz., to which is added ½ oz. of hydrochloric acid. Finally, rinse and dry.

Tin.—Use carbon black mixed with the least possible amount of French polish. Excess of polish makes it glossy. A dye can be used instead of a pigment; for example, boil together 1 oz. of water, 15 grs. of borax, 30 grs. of shellac, and 15 minims of glycerine. Maintain the boiling till dissolved, and then add 60 grs. of nigrosin.

Bellows Interiors.—Use a solution of shellac in methylated spirit coloured with lampblack.

Camera Interior (*Woodwork*).—Dissolve ½ oz. of shellac and ¼ oz. of borax in 10 oz. of hot water, and add about ½ drm. of glycerine and sufficient aniline black (soluble in water) to form a good solid black. Two coats should produce a rich velvety dead black. Another recipe is: Aniline black 50 grs., gum shellac 100 grs., methylated spirit 2½ oz. Negative varnish mixed with powdered lampblack may also be used.

Lampblack mixed with gold size and turpentine makes a good dead black for general use.

BLACKLEAD (Fr., *Plombagine;* Ger., *Graphit*)

Synonyms, graphite, plumbago. Used for lubricating apparatus and in retouching.

In process work, finely powdered blacklead is sometimes rubbed on to wet plate half-tone negatives in order to intensify the dots in certain parts where additional density is required. It is also used in the "Powder Process" or "Dusting-on Process" for the duplication of negatives. As an inert powder it forms an acid resist, and is dusted-on to an ink image for that purpose. In electrotyping it is used to give the wax mould an electro-conductive surface.

BLAKE-SMITH PROCESS

The modern method of toning bromide prints by first bleaching the image or converting it into such a form that treating with a sulphide solution will convert it into sulphide of silver; largely due to the experimental work of R. E. Blake-Smith. Various methods of bleaching the image have been used, but the most simple as well as the most satisfactory is to convert the image into a bromide or chloride by means of a solution containing potassium ferricyanide and either potassium chloride or potassium bromide. (For details of this method, *see* "Toning Bromide Prints," etc.)

BLANC D'ARGENT

A pure white pigment water-colour of French manufacture, largely used by process retouchers, and preferred for aerograph work. Drawings or retouching done with it should be reproduced without delay, as it discolours.

BLANC FIXÉ (*See* "Barium Sulphate.")

BLANCHARD, VALENTINE

Born at Wisbech, 1831; died at Herne Common, November 14, 1901. A famous portrait photographer in the 'sixties and the inventor of apparatus and processes. He was the first to recommend making large transparencies from small negatives, and the art of printing-in clouds from separate negatives, the latter being published on September 4, 1863. He was always opposed to microscopic sharpness in definition, and the slight diffusion which he gained by the use of a single lens caused much attention to be paid his work. He was an advocate of long exposures and large plates, giving about forty-five seconds' exposure and using 15-in. by 12-in. plates for his portraits. His method of obtaining carbon prints without transfer consists in immersing the tissue for a minute in petroleum, the paper support being thus rendered translucent. The tissue, after the removal of the surplus oil, was placed in a printing frame with the support next the negative, printed in the usual manner, and developed from the front. He also invented a brush, known as the Blanchard brush (*see* "Brushes"), which is widely used for sensitising.

BLEACHING NEGATIVES (*See* "Intensification.")

BLEACHING POWDER (*See* "Calcium Hypochlorite.")

BLEACHING PRINTS (*See* "Drawings Made from Photographs.")

BLIND SHUTTER (*See* "Shutters.")

BLINDS, STUDIO (*See* "Studio.")

BLISTERS

Blisters appear at times upon all makes of plates, films, and papers in the manufacture of which albumen or gelatine is employed, but the papers most subject to the trouble are albumen and bromide. The principal cause of blisters is the use of a too strong "hypo" bath, rapid washing, excess of alkali in the developer, and the difference in temperature between the developing, toning, or fixing solutions and the washing water. The blisters usually appear when the plates or papers are being washed after fixing. It is a curious fact that fewer blisters appear where ordinary tap water is used than where soft water is employed. It is, however, the fixing bath that usually needs attention when bromide and gaslight papers are prone to blister. The fixing bath, as freshly made with cold water and "hypo," should not be used immediately, the temperature of such a solution dropping almost to freezing point, and of course many degrees lower than the temperature of the washing water used before and after; hence the expansion of the wet gelatine, which is very susceptible to temperature, in the form of blisters. If a fixing bath is needed quickly it should be made with hot water and used when the temperature has fallen to the level of the washing water; or, if cold water is used, the bath should be mixed some considerable time before use in order that

HEAD OF ENGLISH RAM

By W. L. F. Wastell, F.R.P.S.

it may have time to rise in temperature. When care is not taken about the temperature of the bath, blisters may be prevented by allowing the washing water to run gradually into the fixing bath while the fixed prints remain therein. The water gradually replaces the "hypo," the difference in temperature (if any) is gradually made up, and the expansion of the gelatine is too slow to do any harm; this method, too, largely prevents blisters due to the use of a strong fixing bath.

The use of an acid fixing bath is widely advocated for the prevention of blisters on bromide papers and negatives. Any formula will serve, but that containing "hypo" and metabisulphite will be found best. Another plan is to soak the prints previous to, or immediately after, fixing in a 20 per cent. solution of formaline and then to wash well. There is really no satisfactory cure for blisters when once they have appeared; pricking the paper at the back with a pin for the purpose of allowing the air to escape from the bubble has been advised, but the loosened film never becomes properly attached to the paper, and frequently peels off when dry. Another plan is to squeegee the blistered print upon cleaned ground glass and strip when dry, but, as in the previous remedy, the blisters invariably scale off later.

Information given above on preventing blisters applies equally well to negatives and bromide and gaslight papers. Blisters but rarely appear on negatives, but when they do the negatives should be soaked in methylated spirit and dried; a more general trouble with plates is "frilling" (*which see*).

Albumen paper, as a rule, blisters very badly if carelessly manipulated, the cause being the unequal temperatures of the solutions employed. Rives paper, which is now almost universal, is thought to blister more than the Saxe paper, which is tougher, but not now so widely used. Preventive measures are (*a*) to use solutions of as even temperatures as possible; (*b*) to soak the prints in hot water or methylated spirit, afterwards washing well, previous to toning; (*c*) to remove the prints from the ordinary alkaline fixing bath (acid baths must not be used for albumen paper) to water to which has been added one-tenth its weight of common salt, allowing them to remain for ten minutes and finally washing well.

Carbon prints show minute blisters when the water used is too hot. Blisters may be also due to free air in the water, greater trouble in this direction being experienced when water comes direct from the main than when it comes through a cistern. It is advisable to boil sufficient water for the bath in which the tissue is to be soaked before squeegeeing to the temporary or final support. Fifteen minutes' boiling should be sufficient to expel all the air, and it is then cooled in a jug in order that only a small surface may be exposed to the air, of which water can absorb a large quantity.

Gelatine (P.O.P.) prints rarely blister, but when they do the cause is a too strong "hypo" fixing bath, or the unequal temperatures of solutions and water. An acid fixing bath must not be used for P.O.P.; if hardening is thought necessary, formaline should be used.

BLITZ-PULVER

The German name for flashlight powder. It is occasionally used in English and American literature. In the United States, a powder having this name contains the mixed nitrates of barium and strontium 5 oz., metallic magnesium 2 oz., and amorphous phosphorus 120 to 180 grs.

BLOCK (Fr., *Cliché, Planche;* Ger., *Block, Autotypie-druckform, Autotypieklischee, Galvano*)

A block of wood or metal, or metal plate backed by either wood or metal, and having a typographic printing surface. It may be a process block (produced photographically), a woodcut, in the production of which photography may or may not play a part, an electrotype, or stereotype. "Block Processes" include all those processes in which, by the aid of photography, a relief surface is produced, capable of being printed from in an ordinary printing press together with letterpress.

BLOCKING OUT, OR STOPPING OUT

A method of painting out undesirable details upon a negative, the painted portions appearing white upon the finished print; parts of lantern slides may also be blocked out, in which case the blocking out appears black upon the screen. Blocking out is extensively used on photographs of machinery, furniture, etc., for reproduction in catalogues, etc. It is generally desired that the article photographed should stand by itself upon a white ground, in which case opaque pigment is used as the medium for stopping out the rest of the picture; but when a perfectly black background is required the best thing to do is to make a transparency and block this out, and from this to make a second negative, on which the blocked-out portions will be clear glass, which will, of course, print black. Whichever method is adopted, the actual work of blocking out is precisely the same. In order to do the work properly, the following materials are necessary: a retouching desk, one or two sable or crow-quill brushes with fine points, a mapping pen, Indian ink, ruler, a bottle of black varnish, and red water-colour or other opaque medium. The negative is placed film side uppermost on the retouching desk and the film worked on with the opaque. A rough print to serve as a guide should be taken from the negative before the work of blocking out is begun. It is advisable also to begin from the centre of the negative and work outwards. A retoucher with a steady hand may be able to do all the necessary work with a brush, but many will need the rule, pen and ink. The pen, if used, is charged with Indian ink and held perfectly vertical to the surface of the plate; it should have a smooth and well-rounded point, as otherwise it is apt to cut the film. Any errors made with the pen and ink may be removed by washing away the line by means of a camel-hair brush charged with water; but when this is done care must be taken to wait until the gelatine film is perfectly dry before going over it again with a pen, otherwise the film will be torn. Having ruled all the necessary lines, the rest of the blocking out may be done with the black varnish diluted with turpentine, or with any other opaque pigment. Those pigments used with water are perhaps

the easiest to use because, should any error be made in the work, they may easily be washed off, or wiped off with a damp sponge, whereas black varnish is difficult to remove even with turpentine; the varnish, however, is the more durable, and will stand any amount of wear and tear.

All the fine work, if desired, may be done on the film side with a pen and Indian ink, or with a brush charged with opaque or red water-colour, and the bulk of the stopping out on the glass side with black varnish or Brunswick black, taking care that the working on one side overlaps the other.

Another method is to take a rough print from the unblocked negative, cut out the part required, and use the cut print as a mask, which may be pasted on the glass side of the negative. This serves as opaque, and but little fine work may be required on the film side, care, however, being taken to let the working on the film side overlap the paper mask. The latter may, if desired, be wetted and placed on the film side, but it is removed more easily from the glass side of the negative. (*See also* "Camphor.")

Any of the above methods may also be employed for transparency work, but in the case of lantern slides it will be necessary to use a stopping-out mixture which will not crack when subjected to the heat of the lantern illuminant concentrated by the condenser.

The present-day commercial practice is for the photographer to make as good a photograph of the subject as he can, supply a good print, and leave the blocking out to the process worker's artist, the work being done on the print and not on the negative. The photographer can often assist matters by seeing that the background is of such a nature that the work of blocking out is facilitated, as the merging of the picture of a machine, for instance, into the background makes it difficult to see where one ends and the other begins. Frequently it is sufficient to run a line of white pigment between the subject and the background, and the process worker then understands that the latter is not to be included. The aerograph is largely used for blocking out on prints, etc.

BLOOD ALBUMEN (*See* "Albumen.")

BLOTTING-PAPER

Used for blotting off water from negatives, and for drying those papers not having a gelatine or sticky surface. Inked and coloured blotting-paper is not suitable. The paper should be as fluffless as possible; special blotting-papers for photographic purposes are obtainable. Ordinary blotting-paper may be freed from all impurities likely to damage prints by pouring boiling water and a hot weak solution of sodium carbonate over it alternatively two or three times, ending with the boiling water. This treatment removes the acids and sulphites, which might otherwise affect the permanency of the silver prints.

BLOW-THROUGH JET (*See* "Limelight.")

BLUE GLASS, PHOTOGRAPHIC USES OF

Blue glass of good quality has several uses in photography. By looking through a piece of it at the view to be taken, or by fixing a sheet of it over the focusing screen, the photographer is enabled to see the subject with its colour contrasts toned down, and will be the better able to judge what the effect will be in a photographic monochrome print. Some years ago blue glass was advocated for glazing studios, but exposures under blue glass need to be longer than under white glass, and the only gain to the photographer is that he is working in a light that is less trying to his eyes. Blue glass is of service if placed over a harsh negative when printing on P.O.P., it having the effect of giving a softer print, inasmuch as certain organic salts are not acted upon as they would be were the blue glass absent. Blue glass is also of service when copying a faded or yellowish photograph; a piece of pale blue glass is held before the lens during the exposure, and the resultant negative gives increased contrasts, and in general is of better all-round quality.

BLUE TONES

These are obtained most easily on blue-print (ferro-prussiate) paper or by using blue carbon tissue, in both cases a blue print being produced. Good blues are difficult to obtain on P.O.P., a blue-black (*which see*) being the nearest. Bromide prints may be partially or wholly changed to a prussian blue. Ferric ferricyanide is usually employed, it being made as required by mixing together solutions of potassium ferricyanide and ferric ammonium citrate, adding a little nitric acid. The formula for the toner is :—

Potassium ferricyanide	45 grs.	10 g.
Nitric acid (pure) . .	24 mins.	5 ccs.
Ferric ammonium citrate	22 grs.	5 g.
Water	10 oz.	1,000 ccs.

If this works too quickly, add more water. Place the prints, after developing, fixing, and washing, in the above, until of the desired colour, and wash in running water for twenty minutes, or until the whites are clear.

BLUE VITRIOL (*See* "Copper Sulphate.")

BLUE-BLACK TONES

In silver printing these can be obtained only by using a toning bath rich in gold, say 1 gr. to 5 oz. or 6 oz., and also a liberal allowance for the prints being toned, 2 grs. or more to each full-size sheet of paper, or fifteen half-plate prints. In addition, a rich print from a strong negative is absolutely essential, the tone of the shadows being very largely determined by their depth. Some toning baths will give blue-black tones much more readily than others; with some, these tones cannot be obtained. In separate toning and fixing the sulphocyanide bath, if strong, will give blue-black tones readily. In combined toning and fixing Bennett's toning bath will give a similar result by increasing the quantities of the B, C, and D solutions. One and a half drams of each should be used to each ounce of the A solution, in place of 1 drm., as given under the heading "Bennett's Toning Bath for P.O.P."

BLUE-PRINT PROCESS

Known also as "Cyanotype" (negative) and "Ferro-prussiate" process, and largely used by

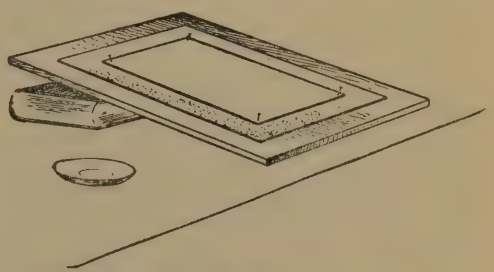
engineers, architects, etc., for reproducing technical drawings. It is one of the oldest photographic printing processes, having been invented by Sir John Herschel in 1840. Paper is coated with a mixture of ammonio-citrate of iron and potassium ferricyanide dissolved in water, then dried in the dark, and printed by daylight in contact with a negative or drawing on tracing paper, when an image in insoluble Prussian blue (Turnbull's blue) is produced. The print is washed to remove the soluble coating unacted upon by light, leaving a finished print, blue on a white ground.

Another blue-print process is the positive cyanotype, or Pellet's process (*which see*, under the latter heading), which gives blue lines on a white ground, the opposite process to the above, it being one in which blue is formed where the light does not act. The negative cyanotype or blue-print process proper is the one particularly suitable for negatives, and is that to which attention is here directed.

Blue-print paper, ready sensitised for immediate use, may be purchased, but as it does not keep well, and is so easy to prepare, it is better to make it as required. A large number of sensitising formulæ have been published from time to time, considerable latitude being permissible in the quantities of chemicals used as well as in the methods of working. They all, however, resemble one another, and yield prints which are all very much alike. Almost any kind of paper can be coated with the sensitive mixture; fairly stout cream-laid notepaper, or a real photographic paper such as Rives, is as good as any; it should be free from wood-pulp or other impurities usually found in cheap white papers, its surface should be fairly hard and not too absorbent, and it should be tough enough to withstand thorough washing. Common rough papers are better if sized before sensitising, because the size prevents the image from sinking into the paper. For the size use the following arrowroot mixture:—Take ½ oz. of arrowroot and mix to a smooth stiff paste with a small quantity of cold water. Add warm water to make 22 oz. in all, and boil gently until clear. Thin papers may be immersed bodily in the warm mixture for a minute or two, and then drained and dried. Thick papers should be pinned by the corners to a flat board and the warm size applied first up and down and then across, by means of a soft sponge or a Blanchard brush (*see* the heading "Brushes"). Then with a clean soft sponge go over the paper again in order to efface all streaks and make the surface smooth; hang up, and when quite dry it is ready to sensitise. The two sensitising solutions are made according to the following formulæ:—

A. Ferric ammonium citrate (brown)	80 grs.	160 g.
Water	1 oz.	1,000 ccs.
B. Potassium ferricyanide	60 grs.	120 g.
Water	1 oz.	1,000 ccs.

Unless quite fresh and clear the ferricyanide crystals should be washed before weighing, and dried between blotting-paper, to free the crystals from powder or crust. Mix the solutions, and keep in a stone bottle or in a dark place. The solution is usable at once, but works better when a week or ten days old, but it must be filtered just before using, and if older than this, should be preserved by adding to every 2 oz. of it 1 gr. of potassium bichromate. The sized common paper or the plain good paper, with blotting-paper underneath it, should be pinned to a flat board, placed (as illustrated) at an angle of about 20° to the horizontal in preference to being either flat or upright. Sufficient of the sensitive solution should be poured into a saucer and then applied to the paper with a sponge, Buckle brush, or large soft camel-hair mop. The coating must be done in artificial light or very weak daylight, and the solution should be spread upon the paper by strokes across the sheet, beginning at the top and joining the second stroke to the first. The strokes should then be made vertically in order that the paper may receive a perfectly even coat, without any of the sensitive mixture running in rivulets down the sheet. When evenly coated the paper must be dried as quickly as possible, and in the dark—a warm cupboard is a good place—but no very great heat should be applied to the wet paper to hasten the drying. The coated paper



Paper Ready for Coating in Blue-print Process

will not keep good for many days; a heavily-coated poor paper will not keep so long as an unsized or lightly sized good one. The colour of the sensitised paper may be a dirty greenish yellow tinge, but will vary according to the sensitising formula. The paper is placed in contact with a negative or drawing on tracing paper, and printed by daylight, preferably in strong sunlight. On exposure to light the colour of the paper gradually changes through bluish-green and bluish-grey to a kind of dirty olive-green, the image having a choked-up appearance when fully printed. The print is washed for about fifteen minutes in water, which should remove the soluble salts and leave a brilliant blue print. The water serves both as a developer and fixer, the print needing no further treatment. Prolonged washing weakens the image, as will also water containing carbonate of lime. Brighter prints are obtained by adding about 20 grs. of citric acid to the pint of water. A solution of 5 parts of alcohol in 95 parts of water has been advocated for improving the whites, and a 2½ per cent. alum solution has been recommended for brightening the blue colour; but neither of these aids is necessary if the water is free from lime, the negative or tracing a suitable one, and the paper properly prepared.

An alternative method is to use single solutions, one for sensitising and the other for developing the faint image, obtained by printing in the usual way, to the desired blue colour. The sensitising mixture is as follows:—

Ferric ammon. citrate (green)	110 grs.	220 g.
Uranic nitrate . .	35 ,,	70 ,,
Water	1 oz.	1,000 ccs.

Paper is coated with this mixture and printed in the manner already described. The faint image is developed to its full strength by placing in—

Potassium ferricyanide	22 grs.	44 g.
Water	1 oz.	1,000 ccs.

The print is completed by washing in water. This process is more rapid than the one first described.

The blue-print processes are used for printing upon fabrics and for the making of blue transparencies for window decoration. For the latter it is necessary to use a plate coated with gelatine to serve as a vehicle for the sensitiser.

Toning Blue-prints.—Blue-prints may be toned to several other colours, but the various formulæ published are uncertain in their action on home-made papers, two samples of which are seldom alike; they answer better with commercial blue-print papers. Before toning, wash the prints thoroughly. *Green.*—Make a saturated solution of ferric protosulphate, acidify with sulphuric acid, and dilute with an equal quantity of water. Immerse the blue-print until the required tint is obtained, wash well, and dry. A weak solution of sulphuric acid (acid 4 drops, water 1 oz.) will also give the print a greenish tinge. *Lilac.*—For lilac-violet, immerse in a hot solution of lead acetate, or a cold solution of borax. A 2 per cent. solution of potassium sulphocyanide (10 grains in 1 oz. of water) gives a pink-lilac tone, after obtaining which blot off superfluous solution, expose to strong sunlight, wash, and dry. *Greenish Black.*—Dissolve 30 grs. of borax in 1 oz. of water and add sulphuric acid drop by drop till the solution just reddens litmus paper; next add a weak solution of ammonia till the red colour begins to change, and finally add 4 grs. of catechu, shake well and filter; tone, wash, and dry. *Brownish Black.*—Add 6 drops of liquor ammoniæ to 1 oz. of water, immerse the blue-print, and allow to remain until the colour has vanished; then wash and place in water 1 oz., tannic acid 9 grs., in which the bleached print gradually assumes a brown or brownish black colour; wash and dry. *Purple Brown.*—Add 30 grs. of tannic acid and 1 gr. of pyrogallic acid (or even less) to 1 oz. of hot water, immerse the blue-print until toned to a lilac, rinse, and place quickly into a weak solution of caustic potash (potash 8 grs., water 1 oz.); wash and dry. *Black.*—A good black is difficult to obtain; success depends upon the quality of the negative and upon the depth of the blue-print. The deep shadows tone to a rich black, but there is a falling-off in the half-tones. Of the many formulæ, Lagrange's is the best, but one of the most troublesome. Rinse the print in distilled water and, in a yellow light, bleach in a silver nitrate solution (9 grs. in 1 oz. of distilled water). Wash well in distilled water, expose to the fumes of ammonia, and afterwards develop with an ordinary ferrous oxalate developer; the print may then be washed and dried. *Grey to Red.*—Print darker than usual, wash for ten minutes, and immerse in a solution of copper nitrate (24 grs. to 1 oz. of water) to which a little liquor ammoniæ has been added cautiously, a few drops at a time, until the precipitate first formed is just redissolved, leaving the liquid a deep blue. This bath turns the blue-print mauve, then grey, and after a time red. Prints dry more blue than they appear when wet. The bath does not act well on prints showing great contrasts, since by the time the dark parts have turned grey the half-tones and lighter tones will become red. Most of the tones obtained by the above methods are unsatisfactory. (*See also* "Window Transparencies" and "Fabrics, Printing on.")

Bleaching Blue-prints.—Instructions are given under "Drawings Made from Photographs."

BLURRING

In a photographic image, the absence of sharp or crisp definition, a point of light becoming a nebulous circle, and a fine line a hazy broad band. Blurring may result from several independent causes. A large working aperture of the lens may be necessitated by the nature of the subject demanding a rapid exposure, and the difference in the various planes of the subject may result in some being out of focus, and consequently blurred. Or occasionally, the entire image may be out of focus, either by accident or design. Many lenses, when used at full aperture, will not give sharp definition over the entire plate, and while the central part is crisp and well defined, the corners are blurred. Or the camera may move during the exposure, with the result that the whole image is blurred. Or, again, in photographing moving objects, the exposure may not be sufficiently short to prevent the object showing movement on the plate. A lens that has been tampered with and put together incorrectly, may give a blurred effect.

BOLOMETER (Fr., *Bolomètre;* Ger., *Bolometer*)

Practically an extremely sensitive thermometer formed of one, two, or four metallic grids or gratings so connected as to form a Wheatstone bridge, and carrying a very sensitive galvanometer mirror. It is used to measure extremely small differences in temperature (0·0000001° C.). S. P. Langley utilised this instrument in conjunction with a series of rocksalt lenses and prisms, and received the deflected light from the galvanometer mirror on a strip of bromide paper. Thus he was able to measure further into the infra-red and map out the absorption lines with remarkable accuracy.

BOLTING CLOTH (Fr., *Etamine;* Ger., *Beuteltuch*)

A material of fine regular texture, originally made for bolting or sifting flour; known also as bolting silk and silk bolting cloth. It is used for obtaining softness of definition in a print. For use when enlarging upon bromide paper, a piece of the cloth, slightly larger than the enlargement to be made, is stretched free from creases on a light wooden frame. This is interposed

between the enlarging lantern and the sensitive paper. It may be tacked over and in actual contact with the paper, but in this case the grain of the fabric shows as a canvas effect in the enlargement; it is more often used away from the paper, the greater the distance the greater being the diffusion obtained and the less marked being the grain. Different effects are obtainable by moving the bolting cloth during exposure, also by giving part of the exposure with the cloth and the remainder without. The interposition of the cloth increases the exposure by about one-third, but this largely depends upon the effect desired.

In contact printing, the bolting cloth is placed in between the negative and the printing paper.

The cloth may be obtained in various degrees of texture and in sheets up to 39 in. by 36 in. It must be carefully handled, as it is easily damaged, and any tear shows upon the finished print. In the hands of an artistic worker bolting cloth is a useful device for obtaining soft pictures.

BOLTON, W. B.

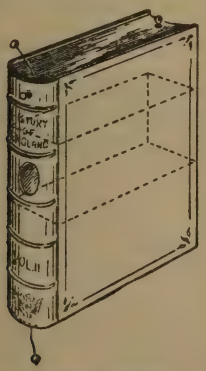
Born 1848; died 1899. Editor of the *British Journal of Photography* from 1879 to 1885. An authority on photographic emulsions; published in September, 1864 (with B. J. Sayce), a formula for collodio-bromide emulsion, and in January, 1874, particulars of a washed collodion emulsion process, this amounting to an almost revolutionary improvement on the unwashed collodion process.

BONE BLACK (Fr., *Noir animal;* Ger., *Knochenfohle*)

The product formed in the retort by heating bones in the absence of air; animal charcoal. It contains about 10 per cent. of carbon and about 80 per cent. of calcium phosphate, the remainder being calcium carbonate and other substances. Used in photography as a pigment in carbon and like processes, also in plate backings and black varnish. Ivory black prepared from ivory chips is a similar but superior pigment.

BOOK CAMERA (Fr., *Chambre à livre;* Ger., *Buchkamera*)

An early form of detective camera, made to



Book Camera

resemble either a book, as shown, or several books strapped together.

BOOKS OF KINEMATOGRAPH PICTURES

(*See* "Kinematograph Pictures in Book Form.")

BORACIC ACID

Another name for boric acid (*which see*).

BORAX (Fr. and Ger., *Borax*)

The common name for sodium borate (*which see*). Also known as sodium biborate or pyroborate.

BORAX TONING

A certain and reliable method of toning sensitised albumenised paper and some forms of plain salted paper prepared and sensitised by the worker. It is not very satisfactory as a toning bath for gelatino-chloride of silver emulsion papers that is, for the modern printing-out paper. A good formula is:—

Borax . . .	80 grs.	23 g.
Gold chloride . .	1 gr.	·28 ,,
Water . . .	8 oz.	1,000 ccs.

The borax should be dissolved in boiling water, and when the solution is cool the gold should be added. The prints must be washed well before toning, and when the desired tone is obtained they should be rinsed in two or three changes of water and then fixed in the usual manner.

BORDER PRINTING

This is an alternative to mounting a print. A sheet of paper and a printing frame, both larger than the actual picture, are used, and by masking the negative the print appears in its first stage with a plain margin. Masks are next used to cover the picture itself, and also the plain margin with the exception of an edge all round the print. A second exposure then gives a narrow border to the picture. This method may be elaborated almost indefinitely, and special printing frames are made to minimise the difficulty of securing accurate registration. Used with discretion and taste, good effects may be secured by surrounding borders of varying width and tint, the great advantage being that the tone and quality of the tints are the same as in the picture itself. The great pitfall is over-elaboration, resulting in distracting attention from the picture itself. (*See* "Borders, Fancy.")

BORDERS, FANCY

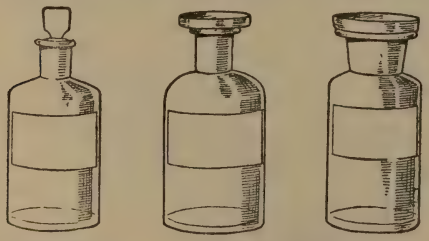
These are generally made by means of special negatives (films, as a rule), which may be bought commercially in considerable variety. The subject is first printed while the margin is masked and then the border printed while the picture is masked (*see* "Border Printing"). Some of the more tasteful of these borders are effective in making picture postcards, cards with Christmas greetings, and so on. When a small subject is used, on a postcard, for example, a well printed border of good design and tone is preferable to a bare expanse of white. At the same time, however, a picture of real value will practically never gain in effectiveness by such an addition, and the suitability or otherwise of a fancy border for the purpose in hand needs careful consideration.

BORIC ACID (Fr., *Acide borique;* Ger., *Borsäure*)

Synonym, boracic acid. H_3BO_3. Molecular weight, 62. Occurs in shining scales or amorphous powder. It is used in pyro developers as a restrainer and to prevent stains, and also in the fixing bath as a stain preventer. A solution of 30 grs. of the acid in 1 oz. of water has been recommended for stopping development instantly. In cases of very great over-exposure it works well as a restrainer, the proportions being 3 drops of a saturated solution added to each working ounce of developer. A formula for a pyro-hydroquinone developer containing boric acid is given under the heading "Developers, Mixed." As a preservative, 10 grs. may be added to each pint of developer, and it will then also act as a restrainer. In a fixing bath it may be added in the proportion of 70 grs. to each ounce of dry "hypo" used, but should not be used after an acid developer. It was at one time recommended as an addition to the combined toning and fixing bath, but it is next to useless employed in that way, and may possibly harm the prints. However, Eder recommends its addition to the "hypo" bath when used before toning. (*See* "Toning after Fixing.")

BOTTLES (Fr., *Bouteilles, Flacons;* Ger., *Flaschen*)

Narrow-mouthed bottles A are best for liquids, and wide-mouthed ones, B and C, for solids. Those with flat-topped stoppers are preferable, it being then less easy for dust to collect in the space between the neck and the stopper. A useful and neat type of bottle has a space for a label ground on its side, on which the name of the substance may be written in pencil, or with waterproof Indian ink. Corrosive and volatile substances and solutions, and deliquescent or moisture-absorbing chemicals require to be kept in bottles provided with well-ground stoppers. The stoppers of acid bottles should be rubbed round with vaseline, which renders them perfectly air-tight and prevents them from sticking; the same may be done to the stoppers of bottles containing caustic alkalis or carbonates, which have a slightly corrosive action on glass. Hydrofluoric acid, which attacks glass, must be kept in a guttapercha or lead bottle. Dark or orange-



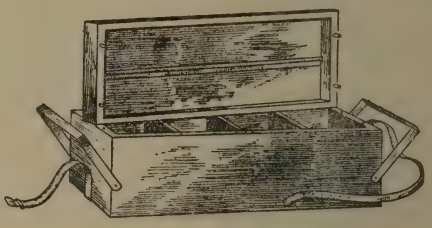
A. Narrow-mouth Bottle

B and C. Wide-mouth Bottles

coloured bottles are used for substances that are deteriorated by light. Corked bottles are not recommended for photographic purposes, except for chemicals that will keep well and are not in frequent use. They may be rendered air-tight by melting wax over the cork and round the neck. A convenient way of doing this is to hold a lighted candle above the cork, allowing the melted wax to run all over and around it. (For special bottles of various kinds, as collodion bottles, dropping bottles, etc., *see* under separate headings.)

BOX, LANTERN-SLIDE (Fr., *Boîte aux épreuves pour projections;* Ger., *Laternbilderkasten, Diapositivkasten*)

A long wooden or metal box with a hinged lid, grooved for the storage of lantern slides. The ordinary pattern resembles a grooved negative box, but some workers prefer plain boxes without grooves, and for storage purposes only these are sometimes of greater convenience, since a number of slides can more readily be

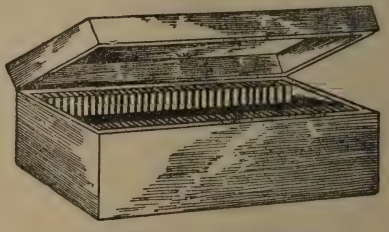


Lantern-slide Box

inserted or removed at once; however, for reference or indexing requirements the grooved type is preferable. Travelling lantern-slide boxes are designed with a view to the prevention of breakage; the example shown is fitted with a rubber buffer at top and bottom to stop any movement of the slides, and has strong brass end fasteners and leather straps. The lid is furnished with pegs fitting closely into holes in the top edges of the box.

BOX, NEGATIVE (Fr., *Boîte aux clichés;* Ger., *Negativenkasten*)

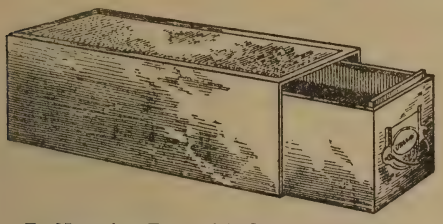
A box, usually either of wood or metal, for the storage of negatives. The ordinary grooved wooden type is shown at A, but there are several other patterns. In one B there is a grooved drawer sliding in an outer case, and this offers the advantage that any given negative can be examined without disturbing other boxes above,



A. Grooved Box for Negatives

and possibly without even needing to remove the drawer. Either single drawers, which can be added to as desired, or drawer cabinets may be obtained. Another type of negative box has an outer shell made like a book with a label to indicate the contents, and having an inner grooved case that slips into it from the back.

Grooved metal boxes are also made, with slip-on lids. One pattern is an adaptation of the card index and vertical filing system, the negatives being kept in numbered envelopes, on which

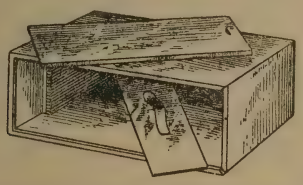


B. Negative Box with Grooved Drawer

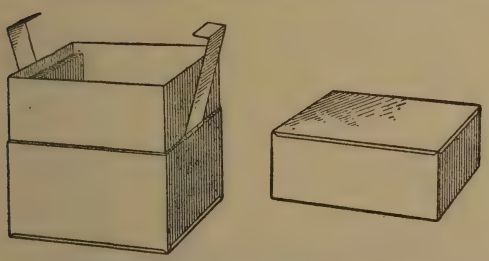
full particulars can be written, and an index card is also provided. Guide cards may be used to divide or subdivide the negatives, and as there are no grooves a good deal of space is saved.

BOX, PLATE (Fr., *Boîte aux plaques ;* Ger., *Plattenkasten*)

A light-tight wooden or metal box, usually grooved, for the safe custody of unexposed or undeveloped plates. Such boxes are made in various patterns. Some resemble grooved negative boxes, but are more carefully constructed, with a deeper lid and rebate. Others A have an outer sliding lid, together with an inner lid furnished with a spring, which keeps it pressed



A. Wooden Plate Box with Double Lid



B. Metal Plate Box with Slip-on Lid

tightly down over the plates when the outer lid is in position. Metal boxes with slip-on lids and spring dips fastening over the latter B are also obtainable.

BOX-FORM CAMERA (Fr., *Détective ;* Ger., *Kasten-Kamera*)

A non-folding hand camera in the shape of a box. It is generally of fixed focus, though sometimes there is a focusing adjustment. The majority of box-form hand cameras have a magazine to hold a number of plates in sheaths ; or provision is made for carrying roll films, or a pack of flat films. (*See* "Hand Camera.")

BOUDOIR

A commercial size and style of mount largely used by professional photographers. The average size of a boudoir print is 8 in. by 5 in.—that is, a trimmed whole plate, and the mount may measure anything from 8½ in. by 5½ in. upwards. Boudoir midget mounts measure about 3⅜ in. by 2 in.

B.P.

The initial letters of the words "British Pharmacopœia," which is an official catalogue, published from time to time by the General Medical Council, giving the standards of purity of drugs, etc. The Pharmacopœias of different countries vary slightly. The initials, when found in a formula, mean simply that the chemical named should be of the standard strength and purity.

BRASS, BLACKENING

Recipes for dead blacks for application to brass are given under the heading "Blackening Apparatus."

BRASS ETCHING

Brass is etched in intaglio or relief by means of ferric chloride, the same as in copper etching. The resist image is generally applied by the enamel process.

BRASSES, PHOTOGRAPHING

Memorial brasses are frequently difficult to photograph owing to their position, but unfixed brasses may be arranged so that a suitable light (preferably a side light) falls upon them. When the light or reflections are troublesome, it is a good plan to dab the brass with a rag dipped in whitening. If the camera is pointed upwards or downwards to the brass, take care to have the focusing screen—and, of course, the plate—vertical. The stop should be small and the plate should be a slow or medium one of the isochromatic variety. As a rule, rubbings from old brasses make better photographs than the brasses themselves.

BREATH PRINTING (Fr., *Impression à l'haleine ;* Ger., *Atemkopieren*)

A curious process, due to Sir John Herschel, by which invisible, or latent, photographs may be produced, capable of development by the breath or by a moist atmosphere. A solution of silver nitrate (sp. g. 1·200) is added to ferro-tartaric acid (sp. g. 1·023), a precipitate falling which is nearly redissolved by a gentle heat. A yellow liquid is thus obtained in which the further addition of silver nitrate causes no turbidity. The total bulk of the silver nitrate solution used should amount to half that of the ferro-tartaric acid. Paper sensitised with this liquid, thoroughly dried in the dark, and exposed under a negative or engraving in sunshine for from thirty seconds to one minute, does not yield any visible impression unless over-exposed. To develop the latent image it is only requisite to breathe upon the paper, when a vigorous picture appears as if by magic. Or the print may be laid in a blotting-book, some of the outer leaves of which have been damped by holding them over warm water.

BRENZCATECHIN

One of the names of the developer popularly known as "Pyrocatechin" (*which see*). Known also as ortho-dihydroxybenzene, catechol, and oxyphenic acid.

BREWSTER, SIR DAVID

Born at Jedburgh, 1781; died at Allerly, 1868. Knighted, 1832. He made many discoveries in optics, investigated polarisation of light, invented the kaleidoscope, and in 1844 designed the Brewster stereoscope. In 1836 he visited Fox Talbot and became interested in the latter's method of producing paper negatives; he also corresponded with Claudet, Ross, Hill, and other fathers of photography. He wrote many articles and books (about 400), several of which dealt with photography.

BRILLIANCY

A term implying that a print is bright and clear in quality. It generally accompanies a long range of tones with strong shadows and bright high lights.

BRISTOL BOARD

A fine kind of pasteboard made by pasting down successive layers of thin paper and having a smooth or glazed surface. Its thickness is indicated by the terms 6-sheet, 8-sheet, etc.

BRITISH GUM (*See* "Dextrine.")

BROKEN NEGATIVES

These must not be confused with cracked negatives (*which see*), as they are not treated in the same way. Broken negatives are generally understood to be those in which the film is broken as well as the glass. If the glass only is broken the film can be transferred to another piece of glass, but this method is not suitable when the film as well as the glass is broken, because of the danger of distorting or losing the pieces during the process of stripping. In many ways a mended broken negative is more satisfactory than a film that has been stripped and put on a new glass backing, and some photographers advocate the breaking of the film purposely when the glass is cracked in order that it may be treated as a broken negative. To mend a negative which has been broken into two or more pieces, take each piece and clean the edges free from dust and dirt. The largest portion is then laid upon a clean and perfectly level glass plate, and Canada balsam diluted with xylol applied to the edges very thinly with a small camel-hair brush. Xylol (or xylene) is a coal-tar product, and if it is not obtainable benzene can be used in its place. The remaining pieces of the negative are also touched all round the edges with the cement, and are then carefully joined so as to fit exactly. The addition of xylol enables one to use the balsam without heating, and as it has about the same index of refraction as glass, the internal surfaces of the glass, if correctly placed together, will no longer reflect light, and the breaks will hardly be perceptible. The surface of the film is afterwards cleaned with a piece of cotton-wool dipped in benzene. Negatives carefully mended in this way show no sign of breakage if printed slowly in the shade.

BROMEOSINE (*See* "Eosine.")

BROMHYDRIC ACID (*See* "Hydrobromic Acid.")

BROMIDES

Salts formed by the action of bromine on a metal, with the characteristic formula M_2Br.

BROMIDE EMULSION (*See* "Emulsion.")

BROMIDE ENLARGING (*See* "Enlarging.")

BROMIDE PAPER (Fr., *Papier au bromure;* Ger., *Bromsilber papier*)

Paper coated with an emulsion of silver bromide in gelatine, for contact printing and direct enlarging by natural or artificial light. It is prepared with a variety of surfaces. Made and introduced commercially about 1874, but not on a large scale until 1880. Working details are given under the heading "Bromide Process."

BROMIDE PAPER NEGATIVES

Bromide paper may be used in place of dry plates for negative making. The process is described under the heading "Paper Negatives."

BROMIDE PENCILS (Fr., *Crayons au bromure;* Ger., *Bromidpinsel*)

Black crayons used in working-up bromide enlargments and prints, platinotypes, etc. They are obtainable either in cedar pencils or as points for adjustable holders, and are sharpened by rubbing on a piece of No. 0 glasspaper. White crayons are also procurable. For a blue-black enlargement it is important not to employ a brown-black pencil, or the work will show too much; and it should be remembered that ordinary black chalk drawing pencils have frequently a tendency to brownness.

BROMIDE PROCESS

The essential feature of the bromide process is its suitability for obtaining either contact prints or direct enlargements by artificial light, and the consequent facilities that it gives for securing any desired result with absolute certainty. If a print is produced which is not exactly in accordance with the result desired, a second exposure may be made while all the conditions remain absolutely constant, and the time of exposure may be so modified that the second print will give exactly the effect desired. In adopting the bromide process, the following conditions are desirable. A light that can be kept as uniform as possible, a means of fixing the relative positions of light and printing frame so that the distance between them is always the same, and the exclusive use of one brand of bromide paper. The distance between the light and frame should be so adjusted that exposures will vary from ten seconds for a moderately thin negative up to forty or fifty for a strong or dense plate. It is impossible to work accurately if exposures are as short as two or three seconds; such exposures cannot be timed with certainty, whereas longer exposures can be timed with an inappreciable percentage of error. Correctness of exposure is absolutely essential in bromide

printing if good results are desired; there is no more fruitful source of imperfect prints than incorrect exposure, and the consequent attempts to compensate by incomplete or forced development. A perfect bromide print is one that has been so exposed that full development with a normal solution will give the contrast and depth required. In order to expose a print in this manner, it will be found desirable to make a preliminary trial exposure on a small slip of paper, selecting a portion of the plate that has part of the densest tones. An ordinary piece of paper may be cut into six or eight trial slips, and several may be exposed on different negatives and developed together. The development of these trial slips should be full, in order that the correctness of the exposure may be judged from the final appearance when in the fixing bath.

Another prolific source of loss of quality in bromide work is the system of using one portion of developer for several prints in succession. The prints last developed are inferior in colour and general quality, and if toning is afterwards performed, the colour is very poor and weak. For prints of moderate size, sufficient developer should be taken for one print, the solution used once and then thrown away. For small prints this is also the preferable plan, but as the quantity of solution necessary is much larger relative to the size of the print, it may be permissible to use the same solution for two prints in succession, or, better, to develop two prints together. But this should be the limit.

Where practicable, as in the case of an incandescent electric light or an inverted incandescent gas burner, the frame should be placed horizontally below the light for making the exposure. It will facilitate shielding parts of the negative during the exposure, and also the making of the exposure by uncovering and recovering the frame, using a sheet of card.

Diamidophenol and amidol are good developers for bromide prints, but they cannot be kept in solution satisfactorily for more than three days. The seriousness of this objection is realised when only two or three small prints are required, and then no more wanted for perhaps a week. Amidol is, however, a favourite with many workers, on account of the fine blue-black colour of the prints produced with it. Ortol is also a good developer for bromide paper, and it keeps for a long time in solution. Metol and hydroquinone form a developer that is a favourite with many workers, as it keeps well in solution. Excellent formulæ are as follow :—

Diamidophenol Developer for Bromide Paper

Diamidophenol (or amidol)	16 grs.	4·4 g.
Sodium sulphite . .	160 ,,	44 ,,
Potassium bromide .	4 ,,	1·1 ,,
Water	8 oz.	1,000 ccs.

The sodium sulphite must be dissolved in the water first. This solution is used without dilution.

Ortol Developer for Bromide Paper

A.	Ortol . .	4 drms.	54 g.
	Potass metabisulphite	2 ,,	27 ,,
	Potassium bromide	1 ,,	13·5 ,,
	Water . .	10 oz.	1,000 ccs.

The potassium metabisulphite must be dissolved in the water first.

B.	Sodium carbonate .	2 oz.	218 g.
	Sodium sulphite .	2 ,,	218 ,,
	Water . . .	10 ,,	1,000 ccs.

To develop, take 40 minims of A, 80 minims of B, and add sufficient water to make 1 oz.

Metol-Hydroquinone for Bromide Paper

A.	Metol . . .	10 grs.	2·3 g.
	Sodium sulphite .	120 ,,	27 ,,
	Hydroquinone .	30 ,,	7 ,,
	Potassium bromide	10 ,,	2·3 ,,
	Water . .	10 oz.	1,000 ccs.

Dissolve the constituents in the order given in the formula.

B.	Sodium carbonate .	½ oz.	55 g.
	Sodium sulphite .	¼ ,,	27·5 ,,
	Water . . .	10 ,,	1,000 ccs.

Mix equal parts of A and B to form the working developer.

All these formulæ produce rich prints of a good, pure colour, which will tone quite satisfactorily. Full development will take about three minutes with the diamidophenol and metol-hydroquinone formulæ, and four minutes with the ortol. The print should be soaked in water for about half a minute, the water then drained off, and the developer flowed evenly over the surface, the dish being rocked until development is completed. Then the print should be rinsed and immersed in the fixing bath, taking care that the prints do not cling together and that the solution has free access to their surfaces. An acid fixing bath is preferable, containing 1 oz. of potassium metabisulphite to 1 lb. of "hypo," the solution being so mixed that 1 pint should contain 3 oz. of "hypo." The prints should remain in the fixing bath for fifteen minutes, and should afterwards be thoroughly washed. From one to two hours, in water frequently changed, according to the frequency of the changes, and the number of prints in the dish, should be sufficient.

Daylight can also be used for bromide work if desired, and many prefer it for enlarging purposes, though it is not suitable for contact printing. (*See also* "Enlarging.")

BROMIDE OF URANIUM PLATES

Plates coated with a silver bromide collodion emulsion containing a small quantity of uranium nitrate to keep it free from fog; these plates are now obsolete.

BROMINE (Fr., *Brome;* Ger., *Brom*)

Br. Molecular weight, 80. Solubilities, 1 in 28 water, very soluble in alcohol, ether, and solutions of alkaline bromides. A deep reddish brown liquid giving off at normal temperatures an extremely irritating orange vapour. It is rarely used in photography except in its salts, though bromine water has been suggested for bleaching bromide prints prior to sepia toning.

BROMINE WATER (Fr., *Eau bromée;* Ger., *Bromwasser*)

An orange-yellow solution, formed by shaking bromine with water and decanting from the excess which settles at the bottom of the bottle.

BROMISED COLLODION, OR BROMO-IODISED COLLODION (*See* "Collodion.")

BROMISER

A solution of alkaline or metallic bromides usually kept in a separate solution and added to collodion just before coating the plate therewith. (*See* "Collodion, Wet.")

BROMO-ARGENTOTYPE

An obsolete name for bromide paper.

BROMOIL PROCESS

A process of obtaining pictures by bleaching and pigmenting bromide prints; suggested by E. J. Wall in 1907. Working details were first published by C. Welborne Piper in August of the same year, and the modified process, as now worked, was introduced in the following month.

Prints for the ordinary oil-pigment process (*which see*) are made by contact, and as the pigment process is generally more suitable for prints of fairly large size it follows that users of small plates must make an enlarged negative before they can produce an ordinary oil print. It was to obviate this that the bromoil process was devised. Essentially, it is a means by which a bromide print (which, of course, may be an enlargement from a small negative) can be prepared for pigmenting. Special bromide papers for this purpose are obtainable, although many of the ordinary brands are equally suitable. The print should not be too old, and it should possess certain qualities. A flat print, or one whose development has been curtailed, will seldom give a satisfactory result. The exposure should be so adjusted that when the developing action has been carried to its fullest extent the result is a clean, strong print, rather more vigorous than would be desirable if it were intended to remain unaltered. Amidol is a good developer for the purpose, a suitable form being 50 grs. of dry amidol added to 20 oz. of water in which 1 oz. of sodium sulphite has been dissolved. The print is fixed in plain "hypo" solution, and very thoroughly washed. At this stage the prints may preferably be dried. Subsequently they are re-soaked for a few minutes to facilitate the even action of a bleaching solution. A suggested formula is:—

Citric acid . .	120 grs.	12·5 g.
Potassium bromide .	120 ,,	12·5 ,,
Potassium ferricyanide	120 ,,	12·5 ,,
Potassium bichromate	240 ,,	25 ,,
Alum . . .	480 ,,	50 ,,
Water to . . .	20 oz.	1,000 ccs.

Dissolve in the order given. It is well to crush the crystals, dissolve in hot water, and use when cold. This is applied to each print separately until the black image is entirely changed to a yellowish brown colour. The prints are then washed until the bichromate stain is removed, and they are then placed for about five minutes in a bath containing 1 oz. pure sulphuric acid to 20 oz. of water. This is prepared by adding the acid slowly to the water, and as considerable heat is generated it should be made some time before use, or blistering of the print will result.

After a short washing, the prints require five minutes' immersion in a solution of 2 oz. of "hypo" crystals and ½ oz. of sodium sulphite in 20 oz. of water. A further washing to eliminate most of the "hypo" brings the prints to the stage where pigmenting may be proceeded with.

There are many variations of the routine of preparing the print. For example, many workers prefer to dry the prints again, and re-soak them for pigmenting. Others omit the acid bath from the preliminary stage, and use it immediately before this second soaking instead. When the prints are only soaked in water before pigmenting it is generally advisable to see that the temperature of the water is at least 65° F. (about 18° C.) in order to secure the necessary swelling and relief in the gelatine. (For an outline of the method of finishing the prepared print by pigmenting, *see* the heading "Pigmenting.")

A modification of the bromoil process has been made for the preparation of lithographic transfers, especially in large sizes for poster work. The bromide paper used should be the so-called "carbon" or velvet surface, and should be of a good substance. An enlargement of a half-tone negative is made on to the paper, which is then developed with amidol, though some workers prefer pyro-ammonia. The print is fixed and washed as usual. It is next bleached in the usual bromoil bleaching solution at a temperature of 75° F. (about 24° C.) for two minutes; soaked in a 5 per cent. solution of sulphuric acid for six minutes; washed in several changes of water for five minutes; fixed in "hypo" or toned with sodium sulphide for one minute; washed in water for five minutes; and dried thoroughly. It is inked all over with a composition roller charged with lithographic printing ink thinned with turpentine, until a thin even coating is laid upon the surface; five minutes or so is allowed for the turpentine to evaporate completely, and the print is then immersed in water at about 70° F. (about 21° C.), and after soaking for about half an hour the transfer may be developed in exactly the same way as an ordinary bichromated gelatine transfer.

BROMO-IODIDE OF SILVER (*See* "Silver Bromide.")

BRONZED PRINTS

Prints on certain makes of papers which have a metallic appearance when held at a suitable angle. The effect occurs chiefly upon self-toning papers and sometimes upon platinum prints, more particularly when the print has been over-exposed or made from a negative having very clear shadows. The more sensitive the paper the more likely are the deep shadows to be bronzed. Bronzed shadows may be eliminated usually by applying a print varnish, or rubbing with wax or encaustic paste.

BROWN TONES (*See* "Sulphide Toning," etc.)

BRUSH DEVELOPMENT

The development of negatives, bromide prints and platinum prints by applying a suitable developer by means of a brush instead of immersing in the developer. For negatives the slower-

working developers, such as pyro, are more suitable than the rapid kinds, such as rodinal, metol, etc. It is usual to soak the plate in a very weak developer until the image just begins to show, and then to rinse in water and apply the weak developer, or even a normal developer, by means of a camel-hair mop, giving the partially developed negative repeated rinses in water in order that there may be no distinct line of demarcation. Where a sharp line is wanted, glycerine may be mixed with the developer. The brush method enables parts of the negative to be subdued or accentuated in a wonderful manner. The process is perhaps of the greatest service in portrait work where white dresses are likely to give undesired effects. It is more widely used in the United States than in England, and R. W. Phillips, an American, recommends the following method of brush development for portrait work; a three-solution pyro-soda formula is used: A. Water 20 oz., sodium sulphite ½ oz.; when dissolved add enough pure acetic acid to turn blue litmus paper red, then add 1 oz. of pyro. B. Water 16 oz., sodium sulphite 4 oz. C. Water 16 oz., sodium carbonate 4 oz. To make a normal developer add 1 oz. of each of the three solutions to 8 oz. of water. For brush development two working solutions are made up, one the normal developer given above, the other being the same, except that the carbonate is omitted. Then use a separate solution of one-half carbonate and one-half water, or two-thirds carbonate and one-third water, whichever is found to suit the strength of the negative desired. In the case of a plate exposed on a sitter in white drapery, develop until the image shows faintly, then pour off this regular developer and wash the plate. Next pour on the pyro and sulphite solution previously made up, hold the negative horizontally up to the light in the hand, and with a camel-hair mop saturated with the carbonate solution rub over that portion of the negative which is to appear the most prominently. This must be done the first time very quickly, putting the negative back into the solution immediately. The operation is then repeated, the carbonate being well blended over the plate so as not to show streaks and defined lines.

The principle involved is this: the negative is developed only to a slight extent in the first immersion, and as soon as the pyro and sulphite solution is poured on development practically ceases. Then the high lights are controlled absolutely with the carbonate solution. Some little practice is necessary in order to get a perfect result. Over-exposed negatives are unsuitable for brush development, the control being so difficult.

It is found rather difficult to carry out delicate work of this character in the dark-room, and there is a very serious risk of exposing the plate too freely to the light, and so producing fog and loss of quality.

In bromide printing, brush development is very frequently adopted for large prints. A smaller quantity of developing solution can be employed than most workers could use satisfactorily in a dish, though the results produced by the brush method are almost always inferior in richness and quality to those obtained in the ordinary manner. The print is thoroughly wetted, so that it will lie perfectly flat on a sheet of glass, and the developing solution brushed rapidly over its entire surface in the manner described under the heading "Brush Toning"

Platinotype prints may be developed with a brush if glycerine is mixed with the developer. (*See* "Platinotype Process.")

BRUSH TONING

A method of toning in which the solution is applied by means of a brush. This method is occasionally adopted for large prints. A concentrated solution is employed and the print, after washing, is laid on a sheet of glass and the solution rapidly brushed over its entire surface. It is desirable to cover the print with the toning solution as quickly as possible, and each stroke of the brush must slightly overlap the part wetted by the preceding stroke; also, no part of the print must be left uncovered in the first application, or uneven toning will result. The brush strokes are first made along the print, then across, and then diagonally, continuing the work until the toning is completed.

Prints, particularly those on bromide paper, can be brush-toned to two or more colours. The method is widely used for the rapid toning of ordinary gelatine or collodion P.O.P., and almost every formula can be adapted, but the following is considered to be the most suitable. Four stock solutions are necessary:—

No. 1. Ammonium sulphocyanide 1 oz., water to 9 oz.
No. 2. Sodium phosphate 1 oz., water to 9 oz.
No. 3. Saturated solution of borax.
No. 4. Gold chloride solution 1 gr. to 1 drm.

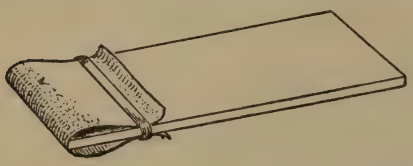
To make up a working mixture take 14 minims of No. 1 and make up to 1 drm. with water; then add 12 drops of No. 4 very slowly, shaking the mixture after each drop is added. Then add 6 minims of No. 2, and finally 16 minims of No. 3. Each ounce of the working solution referred to above contains practically 7 grs. of sulphocyanide, 1 gr. of gold chloride, 5 grs. of phosphate, and 7 grs. of borax, and the bath, if desired, may be made up by adding these quantities to each ounce of water used. By this method, the print exactly as it comes from the printing frame, is placed on a sheet of glass or pinned to a board, and the working solution brushed quickly and evenly over it with a camel-hair mop. Toning should be complete in about two minutes, after which it is washed and fixed as usual.

Great care should be taken not to expose the print to a strong light during the process of toning as otherwise there will be a risk of discolouring the whites.

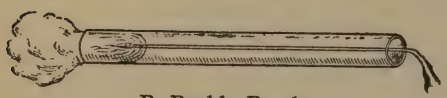
BRUSHES (Fr., *Brosses;* Ger., *Pinsel*)

The most suitable brushes for mounting, colouring, and other photographic operations will be found described under their respective headings. The two brushes (always home-made) most widely used in the dark-room are the Blanchard and the Buckle brushes. The Blanchard brush A is made by taking a strip of glass about 6 in. long and 2 in. wide, and attaching to one end one or two thicknesses of swan's-down

calico, wrapping it round the end and fastening by means of an elastic band or thread. The Buckle brush B is made by drawing some cotton-wool, by means of a loop of silver wire or strong thread, partially through a glass tube, so that a tuft protrudes. Both these brushes are convenient instruments for all kinds of photographic uses, as either the cotton-wool or the swan's-down may easily be renewed. The Blanchard brush is mostly used for applying sensitising solutions.



A. Blanchard Brush



B. Buckle Brush

The Atzpinsel (*which see*) is a special brush used by process workers.

BUBBLES IN LENSES

Small bubbles (or air-bells) are occasionally seen in even the best of photographic lenses, but generally they are no detriment. Their presence, even under the most unfavourable conditions, does not occasion a loss of light exceeding $\frac{1}{50}$ per cent., and their influence upon the optical efficiency of a lens system is therefore of no moment whatsoever. The efforts of opticians during recent years to improve lenses in their higher optical characteristics have led to more extended use of glasses that differ widely in their optical properties and chemical composition from the crown and flint glass hitherto employed, and still used for commoner lenses. Their manufacture is attended by greater technical difficulties, and it is no easy matter to secure perfect freedom from air bubbles.

BUBBLES ON PLATES AND PAPERS

Bubbles or air-bells frequently form on plates and papers during development, and they have the effect of preventing the developer acting on the spots covered by them. The result is clear glass spots upon the negative or white spots upon developed prints. Bubbles invariably arise from stale or frequently used developer, particularly pyro, or they are caused by a careless and uneven flowing of the solution over the surface to be developed. Soaking the sensitive material in water previous to development also causes bubbles to form on the film. A huge crop of tiny clear spots—the result of bubbles—of an irregular form and appearing mostly at or near the edges of the negative, is generally due to an old or oxidised developer, or to one that has been allowed to stand even for a short time after mixing. Larger, round spots are caused by bubbles which attach themselves firmly to the sensitive surface during a preliminary soaking in water, or when the developer is poured on rashly and unevenly. Spots with small black centres are also caused by bubbles; these form during development and cause the gelatine under them to be harder than the developed portions, and therefore slower in fixing, the result being the small specks of unfixed silver bromide in the centres of the spots. The methods of preventing bubbles are obvious. The plate or paper should not be soaked in water before the developer is applied; the developer should be freshly mixed, and poured on to the sensitive surface in an even sweep, first along one edge, and the dish then tilted so as to cover the surface as quickly as possible; the dish should be rocked slowly and regularly, and not violently and in sudden jerks. Many workers pass a clean broad camel-hair brush, a pad of cotton-wool, or a Buckle brush over the film as soon as the developer is poured on, so as to break up and remove any possible bubbles; the brush must, however, be quite clean and soft, or the remedy will be worse than the disease.

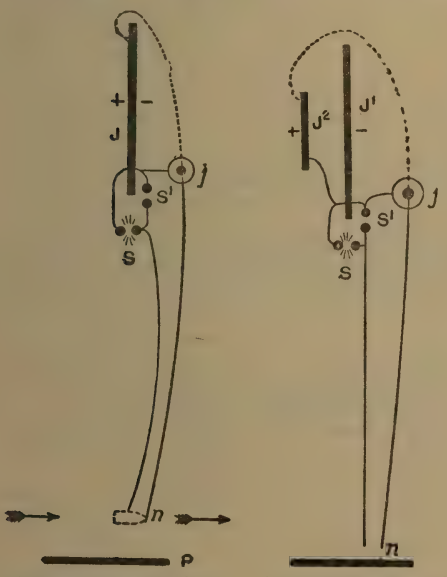
BULLETS IN FLIGHT, PHOTOGRAPHING

The first attempt to photograph a projectile in flight is said to have been made at Woolwich Arsenal in 1860. Owing to the slow wet-plate process used, the results were unsatisfactory. In 1884 some experiments were made at Prague by Mach and Wentzel which were far more successful; these were on the lines described below. In 1887 an improvement on the Prague results was made by Drs. Salcher and Riegler, of Fiume.

Probably the most important experiments in the photography of flying bullets were those published in 1892 by Prof. C. V. Boys, a full account of which will be found in the *Journal* of the Royal Photographic Society (April 30, 1892). His procedure was partly suggested by Lord Rayleigh's methods of obtaining photographs of drops, breaking soap bubbles, etc., which were taken by the light of an electric spark. The following description of the two chief methods employed by Prof. Boys are due to the above-mentioned publication.

The first is shown diagrammatically at A. J is a fulminating pane or condenser of small capacity, which may be charged on its two sides respectively, positively + and negatively —, by means of any kind of frictional or induction machine. This pane is allowed to discharge through a very short circuit in which are two gaps S S^1. The spark at S is allowed to shine on the photographic plate P without the intervention of lenses of any kind. The spark at S^1 is hidden. A second condenser, the jar *j* (of very small capacity compared with the pane J), is connected to J, one coating by means of wire, as shown by the full lines, and the other by means of a string wetted with a solution of calcium chloride, as indicated by the dotted line. Its coatings, therefore, till the time of discharge arrives, are kept at the same potentials as those of the pane J. The discharge circuit of *j* includes the gaps S^1 and *n*. The potential is so chosen that neither condenser is able to discharge across the two gaps S S^1 or *n* S^1 as the case may be, but that either would go off if either of its gaps were

made conducting. This is effected by the passage of the bullet across *n*, which immediately causes a feeble spark at S^1, due to the discharge there of *j*. The air here, being now conducting, no longer prevents the pane J from discharging across the gap S, and therefore a spark is produced which casts upon the photographic plate a shadow of the bullet, and in effect an image of any atmospheric phenomena accompanying the bullet. The difficulty in photographing bullets is to obtain a spark which, while it is bright enough to act on the plate, is yet of such short duration that the bullet has not time to move more than a hundredth of an inch or less while it is yet in existence. If glass lenses are used a large proportion of the actinic rays are absorbed (in the case of a spark between magnesium terminals, four-fifths of the whole); but in the case of a true image any spark formed by the bullet at



A. Arrangement for Photographing Bullet in Flight

B. Modification of of Method A for Photographing Bullet

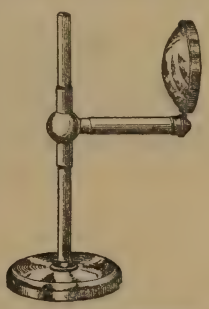
n is properly focused by the camera lens, and does not much interfere with the result. If lenses are not used the whole of the rays (except such as may be absorbed by the air) are effective, but any spark at *n*, being near the plate, would fog it so completely as to make the more distant spark at S almost, if not quite, inoperative. This difficulty is completely avoided by the use of the jar *j*, of very small capacity, which is unable to produce a spark of any appreciable photographic effect. Moreover, the spark at S is brighter, and should last less time when a very short discharge circuit is employed than the corresponding spark produced in the discharge through a greater length of wire, such, for instance, as would be necessary if the main discharge were taken to the bullet and back.

The second method is a modification of the first, and was arranged to meet those cases where difficulty might arise in closing the gap *n*. In the first arrangement the gap *n* must be more perfectly closed than is the small space S, in order to make the action of what may be called the "spark relay" certain. By the introduction of a second pane or jar (*see* B) J^2 in series with J^1, the potential of the little jar *j* may be made $n + 1$ times that of J^1 if the capacity of J^2 is $\frac{I}{n}$ that of J^1. In the discharge, only J^1 is affected, so it will be necessary to discharge J^2 also before beginning a new experiment.

The above sufficiently indicates the principle of the electrical arrangements. With regard to the practical details, the apparatus mostly used consisted of a box lined with black cloth, in which the photographic plate was placed. The large condenser was a plate of glass about a foot square, and the small condenser was a jar or bottle to act as a starter for the spark. The bullet enters and leaves the box by two holes covered with paper to exclude the light, and in passing in front of the plate it touches the terminals of two thin lead wires, thus completing the circuit and causing two flashes—a small one which does not affect the photographic plate, and a larger one which does affect the plate, and has a duration of less than one-millionth of a second.

BULL'S-EYE CONDENSER

A plano-convex (almost hemispherical) lens, mounted upon a stand and fitted with a universal joint. It is used in microscopy to focus the light upon the object, or upon the substage mirror,



Bull's-eye Condenser

and is almost indispensable when examining or photographing opaque objects. Also it is useful for improving the illumination of transparent specimens.

BURETTE

An apparatus used in volumetric analysis to deliver accurately measured quantities of liquids. It consists of a glass tube of uniform bore, graduated, and usually fitted with a stop-cock at the bottom from which any desired quantity of a liquid can be allowed to flow from the tube. A modified form working after the manner of a fountain-pen filler is used for measuring small quantities of photographic solutions.

BURGUNDY PITCH (Fr., *Poix blanche de Bourgogne;* Ger., *Burgunderpech*)

The resin of *Abies* or *Pinus excelsa*, the spruce fir, purified by melting in hot water and

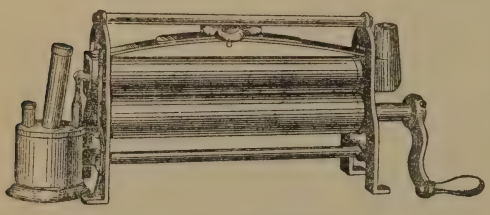
straining. True Burgundy pitch is not easy to obtain, and a fictitious article is often sold for it. The true resin is translucent and has a dull yellowish brown colour, and the fracture is shining and conchoidal; some examples contain much water, and are opaque and of a dull grey colour; they require straining to free them from impurities. The odour is peculiarly aromatic and characteristic. It is not wholly soluble in alcohol of ·838, a little flocculent white matter being left; much the same happens if placed in contact in a vial with twice its weight of glacial acetic acid. It is very soluble in acetone. The false Burgundy pitch is usually brighter in colour than the true, with a weak, scarcely aromatic odour; it is less soluble in alcohol, and in glacial acetic acid it forms a turbid mixture separating into two layers, a thick, oily liquid above and a bright solution below. Burgundy pitch is used in process work in the preparation of photo transfer inks. In solution with spirit of wine it forms an excellent aquatint etching ground.

BURNETT'S PRINTING PROCESS

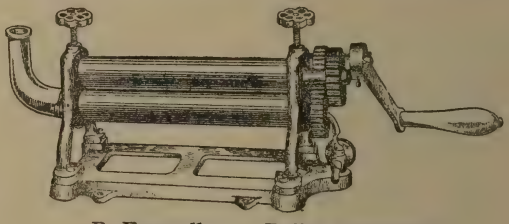
One of the many printing processes employing uranium; invented by Burnett in 1857.

BURNISHER (Fr., *Presse à satiner à chaud;* Ger., *Heisssatinirmaschine*)

A machine for imparting a glossy surface to prints by pressure and friction against a heated and polished bar or roller. The bar burnisher A —the older type—has a polished steel or nickelled



A. Bar Burnisher



B. Enameller or Roller Burnisher

bar and merely a single roller; while the roller burnisher—or, as it is sometimes called, "enameller" B—has two rollers, one or both being of polished nickel. The bar burnisher is said to give the better gloss, but has the disadvantage that the prints need lubricating, and they occasionally get scratched. Both kinds are heated by spirit or gas, or with hollow rollers steam is sometimes employed. Rolling presses, properly so-called, have a large flat steel plate and a single polished roller, and are used either with or without heat.

Burnishers of agate or other stone have had in the past a few photographic uses. (*See* "Agate Burnisher.")

BURNISHING (Fr., *Satinage;* Ger., *Satiniren*)

The method of obtaining a glossy surface on P.O.P. and albumenised prints by drawing them through a heated burnisher. For P.O.P the bar or roller of the burnisher should be just too hot to be touched with the finger, and for albumenised prints a trifle hotter, but excessive heat must be avoided. The prints should not be quite bone dry, and if kept too long they do not burnish so well. On the other hand, they must not be damp, or they may blister and stick to the bar or roller.

When a bar burnisher is used, the prints will require, before burnishing, to be lubricated by rubbing with a mixture consisting of 4 grs. of castile soap dissolved in 1 oz. of alcohol, applied with a tuft of cotton-wool. To dissolve the soap, the bottle containing the mixture is placed in hot water. The print is passed through the burnisher face downward, pulling it upward in a slightly curved direction from the back as it goes through. This is done three or four times. When the print is passed through flat, without pulling it, whether in a burnisher or a rolling press, hot or cold, the operation is known as "rolling"; but this term is frequently applied indiscriminately to burnishing also.

With a roller burnisher, a lubricant is not required. Solid rollers take some time to get hot and require to be rubbed lengthwise with a soft cloth until heated, meanwhile revolving the roller backwards; this is to prevent the deposition of condensed moisture from the air, due to the lower part of the machine getting warm first, while the roller is still cold; this moisture, if allowed to settle and dry on, would make the roller dull and streaky, and might cause rust.

The more modern burnishers have a hollow roller with the gas burners inside it; this gets hot in a much shorter time, and the heat is also more even. A screw adjustment is usually provided for regulating the distance between the rollers, bar burnishers having instead nuts under the plate, or some similar arrangement. Should the steel bar of a bar burnisher become scratched it should be rubbed carefully with a slip of fine oilstone having a little sweet oil on it, until uniformly smooth and bright. The oilstone should be held flat on the bar and drawn from end to end only, not across. Nickelled rollers are difficult to repolish satisfactorily when worn, and generally require sending to be replated.

BURNT-IN PHOTOGRAPHS (*See* "Ceramic Photography.")

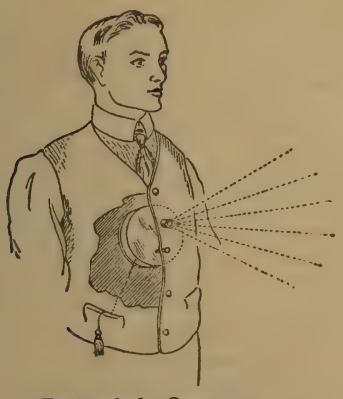
BURTON, W. K.

Born in Scotland, 1853; died at Tokio, Japan, 1899. Author and experimentalist; first became prominent in the early 'eighties as an authority on the theory and practice of emulsion making. Burton was an engineer by profession, and early in 1887 left for Tokio, where, at the Imperial

College, he was appointed to a professorship. He compiled an exposure table and published an "A B C of Photography."

BUTTONHOLE, OR VEST, CAMERA (Fr., *Chambre à boutonnière;* Ger., *Knopfloch-Kamera*)

A small detective camera of circular form, somewhat like a large watch, and worn under

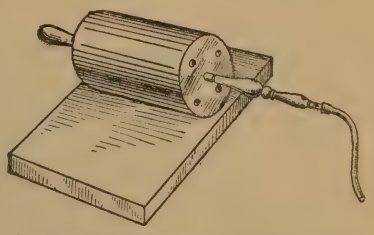


Button-hole Camera

the vest, as shown in the illustration. The lens protruded through a buttonhole. Six round pictures about the size of a penny were taken in succession on a circular plate. The device was invented by Stirn.

BUTTONS, PHOTOGRAPHIC

Celluloid buttons containing photographs. Ordinary prints are first prepared, these being albumen, P.O.P., or bromide, and after fixing, washing, and drying, they are mounted face down with starch or gelatine on sheets of celluloid sold for the purpose. If necessary, the photographs may be mounted before they are dried. When dry the photographs are cut out with a punch or die, placed in a machine with the metal discs, and stamped into buttons. The bent pin, strut, or frame is then attached.



Gas-heated Roller and Metal Plate

Professional workers use a gas-heated roller and metal plate, as shown. The dry print is immersed in alcohol till both sides are moistened. A sheet of blotting-paper is placed on the plate, then the celluloid, next the print, face down, and finally a piece of tissue paper. The roller, sufficiently hot to sizzle when touched with water, is now passed over all, uniting the print and celluloid.

C

"C. DE V."

The abbreviated form of "carte-de-visite" (*which see*).

"CABINET" SIZE

A popular size of professional portrait, having a mount measuring 6⅝ in. by 4¼ in. The actual print may be 5½ in. by 4 in., 5¾ in. by 4 in., or 6 in. by 4¼ in., these being known in the trade as "No. 1," "No. 2," and "Special" cabinet sizes respectively. Cabinets were introduced in 1867 by F. R. Window, of Baker Street, London, who, as a professional photographer, found the then popular carte-de-visite too small for groups and for ladies' dresses, possibly crinolines, which were fashionable between 1856 and 1867.

CACHET, ROUGE ET VERT

Names once given to some French isochromatic plates, "rouge" being of medium rapidity and "vert" special rapid. A French chemist (Tailfer) was the first to make a successful isochromatic dry plate (1882). The British rights to the patent were secured in 1886 by B. J. Edwards & Co.

CADMIUM BROMIDE (Fr., *Bromure de cadmium;* Ger., *Bromcadmium*)

$CdBr_2$, or $CdBr_2\,4H_2O$. Molecular weights, 272 and 344. Solubilities, 1 in 0·94 water, 1 in 3 alcohol, 1 in 250 ether, 1 in 16 alcohol and ether. A yellowish crystalline powder, obtained by heating cadmium to redness in bromine vapour. It is used to bromise collodion.

CADMIUM CHLORIDE (Fr., *Chlorure de cadmium;* Ger., *Chlorcadmium*)

$CdCl_2$, or $CdCl_2\,2H_2O$. Molecular weights, 183 and 201. Solubilities, 1 in 0·71 water, 1 in 8 alcohol. It occurs as small white crystals, which are occasionally used in collodion emulsions.

CADMIUM IODIDE (Fr., *Iodure de cadmium;* Ger., *Iodcadmium*)

CdI_2. Molecular weight, 366. Solubilities, 1 in 1·08 water, 1 in 1 alcohol, 1 in 3·6 ether. It takes the form of colourless flaky crystals.

This salt is preferred for iodising collodion for process negatives, generally in conjunction with ammonium iodide.

CADMIUM-AMMONIUM BROMIDE (Fr., *Bromure double de cadmium et d'ammonium;* Ger., *Zweifach-ammonium-cadmiumbromid*)

$2CdBr_2\,2NH_4Br\,H_2O$. Molecular weight, 758. Solubilities, 1 in 0·73 water, 1 in 5·3 alcohol, 1 in 24 of equal parts alcohol and ether. A double salt suggested by Eder on account of its greater stability for collodion processes. It can be prepared by dissolving 344 parts of crystallised cadmium bromide and 98 parts of ammonium bromide in water and then crystallising.

CADMIUM-AMMONIUM IODIDE (Fr., *Iodure double de cadmium et d'ammonium;* Ger., *Zweifach-ammonium-cadmiumiodid*)

$CdI_2\,2NH_4I\,2H_2O$. Molecular weight, 692. Solubilities, 1 in 0·58 water, 1 in 0·70 alcohol, 1 in 1·8 equal parts alcohol and ether. A double salt suggested by Eder, as it gives greater sensitiveness to collodion than the single salts. It can be prepared by dissolving 145 parts of ammonium iodide and 183 parts of cadmium iodide in water and then crystallising.

CALCIUM BROMIDE (Fr., *Bromure de calcium;* Ger., *Bromcalcium*)

$CaBr_2$. Molecular weight, 200. Solubilities, 1 in 0·7 water, very soluble in alcohol. Very deliquescent. Should be kept well stoppered. A white, granular powder, obtained by neutralising hydrobomic acid with chalk. It is used in making collodion emulsion.

CALCIUM CARBIDE (Fr., *Carbure de calcium;* Ger., *Calciumkarbid*)

CaC_2. Molecular weight, 64. It is decomposed by water, and extreme care must therefore be exercised in storing free from moisture. It occurs in greyish-black, irregular lumps, or sometimes in coarse granules, and is obtained by direct union of lime and carbon in the electric furnace. On being added to water acetylene gas (*which see*) is evolved, slaked lime being left as a residue: $Ca\,C_2 + H_2O = C_2\,H_2 + CaO$.

CALCIUM CARBONATE, OR CHALK (Fr., *Carbonate de chaux;* Ger., *Kreide, Kohlensaures Kalk*)

$CaCO_3$. Molecular weight, 100. Solubilities, insoluble in water, alcohol, or ether. Prepared, or drop, chalk occurs as a white amorphous powder or small cones, and is obtained by washing native chalk. Precipitated chalk is obtained by precipitation from a soluble calcium salt by a carbonate, and should alone be used in photography, as it is freer from impurities; it is an impalpable white powder, and is used to neutralise toning baths.

CALCIUM CHLORIDE (Fr., *Chlorure de calcium;* Ger., *Chlorcalcium*)

$CaCl_2$ (anhydrous), $CaCl_2\,6H_2O$ (crystal). Molecular weights, anhydrous 111, crystal 219. Solubilities, 1 in 1·4 water (anhydrous), 1 in 0·25 water (crystal), soluble in alcohol. It is extremely deliquescent, and must therefore be kept well stoppered. The pure anhydrous salt occurs as a white, granular powder, in sticks or lumps; the hydrated salt as white crystals; both are used occasionally in emulsion making.

The commercial granulated dry chloride ($CaCl_2\ 2H_2O$) occurs in greyish-white porous masses about the size of a pea, and is used as a desiccating agent for platinotype and other papers. When from absorption of moisture it becomes a pasty mass, it can be easily dried in an ordinary oven.

In process work, calcium chloride is used in iodisers for collodion. The dry commercial variety of calcium chloride in hard lumps is used for placing in drying boxes for carbon tissue, gelatine films, etc. Also it is used in calcium tubes for storing sensitised paper.

CALCIUM CHROMATE (Fr., *Chromate de calcium;* Ger., *Calciumchromat*)

$CaCrO_4\ 2H_2O$. Molecular weight, 192. Solubilities, soluble in water and alcohol. It is a yellowish powder, prepared by neutralising chromic acid with chalk. It was suggested by Valenta as an addition to printing out emulsions to obtain greater contrast, and he gives the following method of making a 10 per cent. solution :—

Chromic acid (pure) .	386 grs.	25 g.
Distilled water to .	3½ oz.	100 ccs.

Dissolve, and add sufficient precipitated chalk to make the solution permanently milky after well stirring. Filter, and wash the filter with sufficient distilled water to make 8¾ oz., or 250 ccs., in all.

CALCIUM HYDRATE, OR HYDROXIDE

$Ca(OH)_2$. Molecular weight, 74. A synonym for slaked lime, a substance which has been suggested as an addition to the gold toning bath, but is very rarely used.

CALCIUM HYPOCHLORITE (Fr., *Chlorure de chaux, Chlore à blanchir;* Ger., *Chlorkalk*)

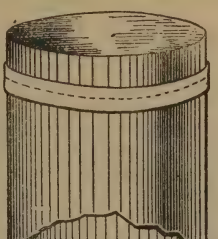
Synonyms, bleaching powder, chloride of lime. Solubilities, 1 in 400 water, 1 in 7·5 alcohol. It is poisonous, the antidotes being ammonia vapour, steam, ether vapour, and dilute sulphuretted hydrogen. It occurs as a white or greyish-white powder with powerful chlorine smell, and is obtained by passing chlorine gas over slaked lime. Its composition is doubtful, but may be considered to be approximately $Ca(OCl)Cl$. It is used for preparing Labarraque's solution and Eau de Javelle (*which see*).

CALCIUM SULPHATE (Fr., *Sulfate de calcium;* Ger., *Calciumsulfat*)

Synonyms, sulphate of lime, gypsum. $CaSO_4\ 2H_2O$. Molecular weight, 172. Solubility, 1 in 380 water. It occurs naturally as the mineral anhydrite $CaSO_4$, and, in combination with $2H_2O$, as alabaster, gypsum, satin-spar and selenite. Gypsum when heated moderately loses its water, becoming what is known as plaster-of-paris, which, when mixed to a paste with water, again takes up $2H_2O$ and sets to a hard solid with expansion. Plaster-of-paris is used for making casts and moulds in some photo-mechanical processes, and for photographic bas-reliefs. It is sometimes useful for stopping leaks and repairing broken articles. It should be kept in air-tight stoppered jars, and only the finest quality should be used for photographic purposes. Calcium sulphate is a common impurity in spring water, causing what is known as permanent hardness, which is not removed by boiling.

CALCIUM TUBE

A tube or box, usually of "tin" (tin-plate), divided into two parts, the larger for storing paper and the smaller for containing calcium chloride. The illustration shows a good home-made pattern. The larger tin holds the sensitive paper, which rests upon a smaller tin having a perforated top and containing the chloride. Such tins may be used for all kinds of paper likely to be affected by damp, and, indeed, are necessary for keeping platinotype paper dry and in a good printing condition. The calcium chloride absorbs the moisture. Platinotype paper is sold in air-tight tins, each of which contains a twist of paper or cotton-wool holding a small piece of asbestos, which has been saturated with calcium chloride; this may be used over and over again by heating on a red-hot shovel to drive out the moisture. Should a



Calcium Tube

new piece be required it may be prepared by taking a saturated solution of calcium chloride, adding to it coarse commercial asbestos, and kneading the whole into small cubes, afterwards drying them in an oven. Calcium chloride may be purchased in the anhydrous form and used in place of the asbestos; it should be tied up in fine muslin or placed in a small perforated tin, care being taken to prevent any particles of it getting on to the sensitive paper.

CALMEL'S POWDER

A mixture of resin, pitch, and asphaltum melted and ground to fine powder for use as an acid resist in photo-etching.

CALOMEL (*See* "Mercurous Chloride.")

CALOSCOPIC LENS (Fr., *Objectif caloscopique;* Ger., *Caloskopische Linse*)

A landscape lens made in the late fifties and early sixties of the nineteenth century. It was designed on the same principles as Petzval's orthoscopic lens.

CALOTYPE, OR TALBOTYPE, PROCESS

A negative process upon paper, invented by Fox Talbot and patented by him on September

20, 1841. It was the third British patent for photography, the two previous ones being for the Daguerreotype process. The patent was afterwards disputed by the Rev. J. B. Reade, but Talbot's claim was upheld in the law courts, mainly for the reason that Reade's previous discovery was not properly published or made known. Fox Talbot's process was afterwards considerably improved by C. Cundall. The original process is briefly as follows: Paper of close texture was washed over with a solution of 100 grs. of silver nitrate in 6 oz. of water. When dry, the paper was immersed in a solution of potassium iodide, 25 grs. to each ounce of water, for two or three minutes, then rinsed in water and dried. Paper in this condition was called "iodised paper," and could be stored in a portfolio for use as required. Sometimes the double operation referred to above was performed at one time by brushing a solution of iodide of silver and potassium over the paper with a Buckle brush. In order to prepare the paper for exposure in the camera two solutions were necessary: A. 100 grs. of silver nitrate dissolved in 2 oz. of water, to which is added one-sixth of its volume of strong acetic acid. B. A saturated solution of crystallised gallic acid. Equal parts of A and B were mixed together, the mixture being called gallo-nitrate of silver. The iodised paper was brushed over with this solution, or the paper floated upon it for half a minute, then rinsed in water or blotted off, the operations being carried out in the dark-room. The paper was then placed, either wet or dry, in the dark slide and exposed in the camera, the exposure necessary being, under good conditions, about six minutes. The paper was developed by washing over with gallo-nitrate of silver (as above), and was fixed, after washing in water, by a minute's immersion in a solution of 100 grs. of potassium bromide in 8 oz. of water. Finally it was washed, dried, and printed from.

Modifications of the process consisted in slight alterations in the sensitising bath, the use of ferric protosulphate as a developer, and of sodium hyposulphite as a fixer, and the making of the paper negatives more easily printable by waxing or by immersion in almond oil. The calotype process was popular between 1841 and 1851, but was superseded by the collodion process

CAMARSAC'S PROCESS (Fr., *Procédè Camarsac;* Ger., *Camarsac's Prozess*)

Lafon de Camarsac was the first, in 1855, to discover the method of making burnt-in photographic enamels, now known as ceramic photographs, or photo-ceramics, and the process was in the beginning named after its originator. (*See* "Ceramic Photography.")

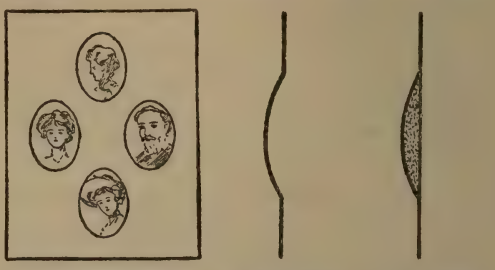
CAMBOGE (*See* "Gamboge.")

CAMEO (Fr., *Camée;* Ger., *Kamee*)

Photographically, a bas-relief portrait finished in plaster-of-paris or coloured waxes. (For working details, *see* "Bas-reliefs.")

CAMEO PRINTS

An old type of professional carte-de-visite portrait, popular between the 'sixties and 'eighties. It was the invention of Messrs. Window & Grove, and in its earliest form, called "diamond cameos," consisted of four positions on one card, as A, and raised as medallions. Later, one position took the place of four, and it became even more popular. After mounting

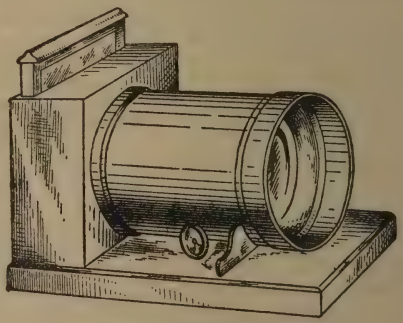


A. Cameo Print, Medallion Style | B. Convexity of Cameo Print | C. Cameo Print backed with Cotton-wool

the print in the ordinary way upon a flat card, it was put in a press and made convex, as B. Another and a more expensive plan was to make only the print convex, and to fill the concave part with cotton-wool before pasting it upon a flat card, as C.

CAMERA (Fr., *Chambre, Chambre noire;* Ger., *Kamera*)

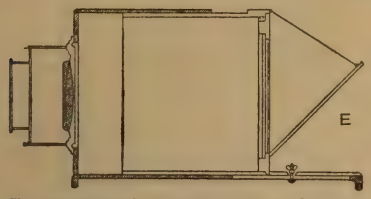
The photographic camera is essentially a light-tight box, having a lens at one end and provided at the other with a suitable arrangement for the insertion and withdrawal of the sensitive plate or film. To ensure that the required amount of subject is included, a ground-glass focusing screen, or some kind of finder or sight, is employed. The prototype of the photographic camera is the camera obscura (*which see*). The first camera used for photography was that of Nicéphore Niepce, who, writing in 1816, describes it as a box about 6 in. square, furnished with a sliding tube carrying a lens. In Daguerre's first camera A the only means of focal adjustment



A. Daguerre's First Camera

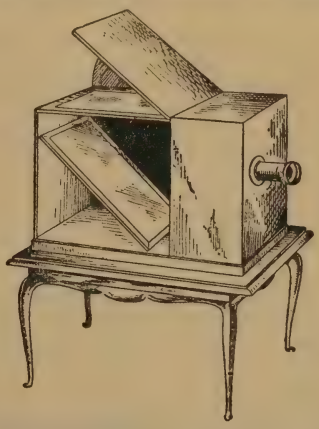
was a rack and pinion on the objective. Charles Chevalier, of Paris, introduced some improvements, among them the method of making the body in two portions, one sliding within the other and clamped by a screw working in a slot on the baseboard, as seen in Daguerre's later apparatus B; this arrangement is still met with in

some ferrotype cameras. The mirror E at the back, to erect the image in focusing, will be noticed. The next step forward was the invention of the bellows, which was probably suggested by that of the accordion, and seems to



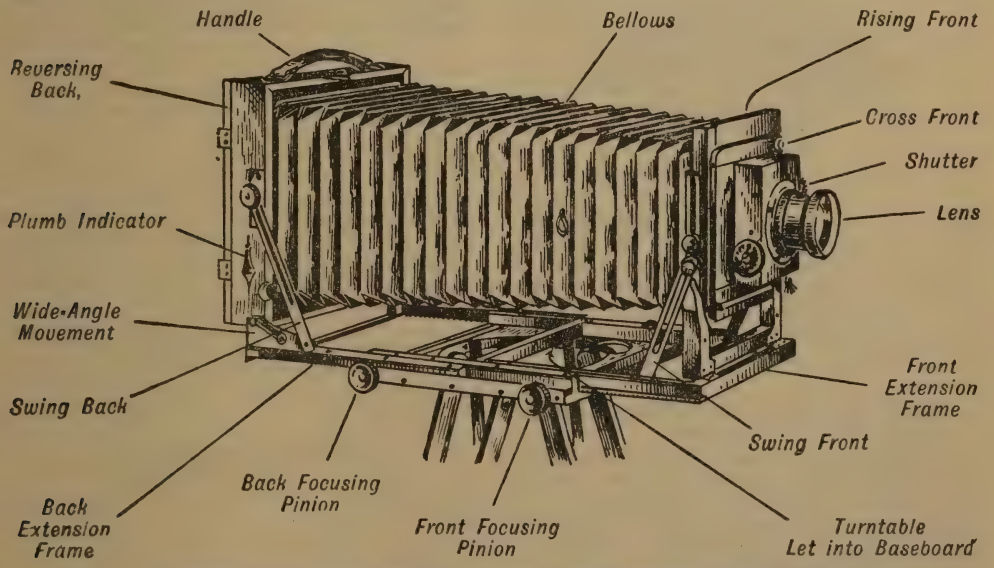
B. Daguerre's Sliding-body Camera

have been known as early as 1839, though it was not in general use till the 'fifties. It was originally square or oblong, and the only way of reversing the plate was to turn the entire apparatus on its side. The pyramidal, or so-called "conical," bellows was first made in 1861, and at about the same period were introduced the swing front, swing back, and side-shifting movement. Since then progress in camera construction has been rapid. The reversing back, rising and falling front, turntable, and many other conveniences, have been added, until the elaborate and beautifully-finished outfits of to-day bear scarcely any resemblance to the heavy and clumsy apparatus of earlier years. Yet, to give a curious instance of how ideas tend to repeat themselves, the latest refinement of mechanical skill, the reflex or reflector camera, is strikingly similar in design to an early pattern of box-form camera obscura C described by the Abbé Nollet in his "Leçons de Physique," published at Paris in 1755. Thomas Sutton, in 1861, was the first to adopt the reflector principle in exposure by hingeing an inclined mirror and using it both for focusing and as a shutter. D will serve to explain the various fittings and movements of a modern triple-extension field camera, each part being named and indicated by an arrow. The different



C. Box-form Camera Obscura: Early Anticipation of Reflex Principle

kinds of cameras are described in this work under their separate headings as "Studio Camera," "Field Camera," "Hand Camera," "Reflex Camera," "Enlarging Camera," etc., and any not so found should be looked for under the particular branch of work for which it is used.



D. Fittings and Movements of Modern Triple-extension Field Camera

CAMERA BAG, OR CASE (Fr., *Sac à chambre*; Ger., *Schnappsack, Sack*)

A receptacle for the carriage and protection of the camera, lens, and slides, commonly of

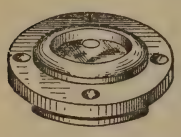
canvas or leather, and generally provided with a strap to sling over the shoulders. The better-class bags are lined with baize, felt, or velvet, and have suitable partitions. A lock and key is a useful precaution against the dark-slides being tampered with when travelling.

CAMERA CARRIER (Fr., *Porte-chambre ;* Ger., *Kameraträger*)

An attachment for carrying the camera, etc., on a bicycle or tricycle. Various patterns are made, with screw clamps to fit on the front, back stays, or handle-bar of the cycle, and furnished with straps or spring clips to secure the apparatus. There is a general opinion, however, that the camera is best carried when slung on the rider's back. (*See also* "Cycle.")

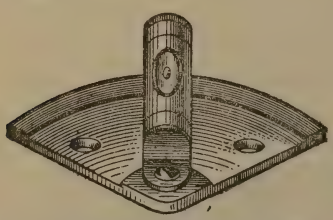
CAMERA LEVEL (Fr., *Niveau ;* Ger., *Nivelle*)

A device to enable the back of the camera to be kept truly vertical or the base horizontal, as the case may be. For the first purpose, a plumb



A. Circular Spirit Level

B. Long Spirit Level



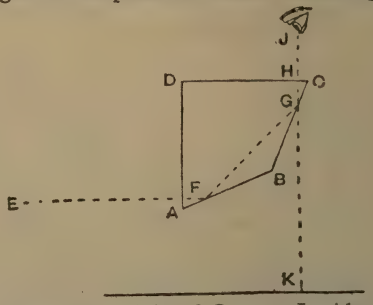
C. Quadrant or Two-way Level

indicator hung at the side is ordinarily employed, though a circular spirit level A let into the top is sometimes preferred. For the baseboard, either a long spirit level B or a circular one is used. There are many patterns of levels, some working with spirit, others having a small ball enclosed. A quadrant or "two-way" level is illustrated at C.

CAMERA LUCIDA (Fr., *Chambre claire ;* Ger., *Die Helle Kammer*)

An instrument used for delineating views from nature and copying drawings. It was a camera lucida that Fox Talbot was using when, in October, 1833, he began to think out a plan for fixing the images seen by its aid, but he at a later date put it aside in favour of the camera obscura. The camera lucida proper was invented by Dr. Wollaston, who died in 1828, but the name was originally given to an instrument, invented by Dr. Hooke, analogous to the microscope.

The best form of the camera lucida consists of a four-sided prism having the vertical cross section A B C D as shown in the diagram. The side A B is at an angle of 22½ deg. with the horizontal, while the side B C makes the same angle with the vertical. A horizontal ray of light from an object E is twice totally reflected at F and G, and emerges vertically from H to J. The eye at J refers the ray to a point vertically beneath at K, and at the same time is able to look over the edge C of the prism at a sheet of white paper



Optical Principle of Camera Lucida

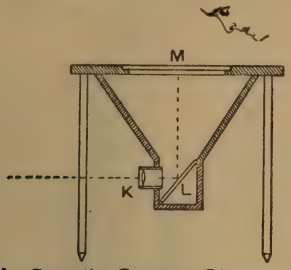
placed below, on which the image of the object is seen, and on which it may be traced with a pencil. The prism is mounted in a brass case, and is fixed by a movable joint to an upright rod about 1 ft. high, provided with a clamp at its outer end to attach it to a drawing board.

CAMERA OBSCURA (Fr., *Chambre obscure ;* Ger., *Die Dunkelkammer*)

Literally, "dark chamber"; an optical instrument invented by Baptista Porta in 1569, although there is evidence of an even earlier knowledge of its principle and properties. This simple instrument depends in principle on the fact that if a tiny hole is made in the shutter of a room from which light is otherwise excluded, a small reversed image of the view outside will, under favourable circumstances, be thrown on the opposite wall. This experiment appears to have been known to philosophers from time immemorial, but only comparatively recently was discovered the improvement effected by using a convex lens in place of the hole. Baptista Porta's box-form of camera obscura appears to have been used as an entertaining toy, or as a ready means of tracing landscapes and views, for nearly three centuries prior to the discovery of photography. A quaint form of camera obscura, designed by A. M. Guyot, for outdoor work in tracing landscapes, is shown in section at A. It resembles an ordinary table, the camera being situated between the legs and the top being formed by a sheet of plain glass M, on which is laid a piece of tracing paper. The image formed by the convex lens K is thrown upwards on the screen M by being reflected from an inclined mirror L. A modification of this device is shown at B, the projected image being viewed under cover of a dark chamber, at the top of which the optical system is arranged. A double convex lens is placed in a sliding mount at K, and over it is a mirror L, set at an angle of 45° relative to the horizon. As the lens is uncorrected for spherical aberration, the image would suffer in definition at the margin if received upon a perfectly plane surface. Therefore the surface M is made concave, and part of a sphere whose radius is the focal distance of the convex lens K.

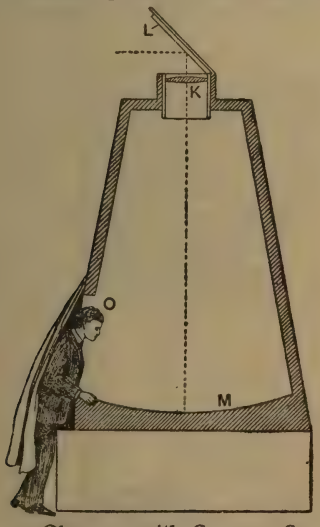
The best form of camera obscura is that in which internal instead of specular reflection is employed, to prevent the loss of light attendant

on the latter. The optical system then consists of a rectangular prism C, having one of its faces convex and another concave, such a combination doing away with the necessity of a mirror to change the direction of the rays from



A. Guyot's Camera Obscura

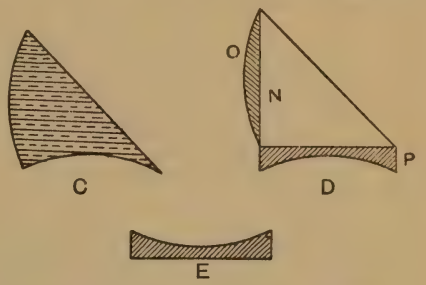
a horizontal to a vertical course. The rays from a distant object or landscape will be made to converge after impinging on the convex surface, and being reflected in the interior of the prism, will pass into the dark chamber to the surface upon which the picture is to be received. The picture thus obtained will be extremely vivid. With an optical system of this character, the surface on which the picture is formed may be plane and not concave. As these meniscus prisms are difficult to procure, they may be replaced by a triangular prism N (*see* illustration D), having a plano-convex lens O and a plano-concave lens P, both of proper focal length, cemented by Canada balsam on two of its faces. Spherical aberration is sometimes guarded against by using a plano-concave lens E, in place



B. Camera Obscura, with Concave Surface to receive Image

of the more complex combination, in which case the lens is placed at the top of the dark chamber with its concave surface uppermost. With this latter arrangement a plane surface suffices to receive the picture, but the mirror L, in illustration B will still be needed to turn the rays from the horizontal to the vertical direction.

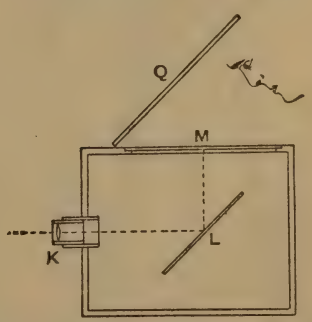
The box-form camera obscura is shown at F, and it will be seen that the principle here employed is practically the same as that of Guyot's table-form apparatus, with the addition of a shade Q. This device is sometimes used by



Prisms and Lenses of Camera Obscura employing Internal Reflection

artists in sketching or, rather, tracing outline pictures of landscapes. K is the lens, L, the mirror, and M the sheet of tracing paper, or ground glass with the matt surface uppermost. The modern photographic camera obscura—which will be readily recognised as the reflex or reflector camera—is arranged in the same way as F, but the lens used at K is of the compound type, in which spherical aberration, achromatism, and all the other defects of a simple lens are corrected; so that when the mirror L is mechanically moved out of the path of the rays a perfect negative image is received upon the sensitive plate, suitably placed at the back of the camera.

A sterescopic camera obscura devised by Theodore Brown is a half-plate instrument fitted with a mirror for reflecting the rays on to a horizontal screen where the stereoscopic images are seen. Unlike an ordinary stereoscopic camera, in which a pair of lenses side by side are used, only one lens is used, but it is supplemented with a double reflecting device (the "Stereophotoduplicon," *which see*), to be used on the hood of the single lens. The effect is very



F. Diagram of Box-form Camera Obscura

charming, especially when the face of the observer is properly enclosed within the hood or shade placed above the screen on which the dissimilar images are projected. By turning the camera on its axis during inspection of the images a panoramic, as well as a stereoscopic, natural colour effect is produced.

CAMERA SCREW (Fr., *Vis du pied;* Ger., *Stativschraube*)

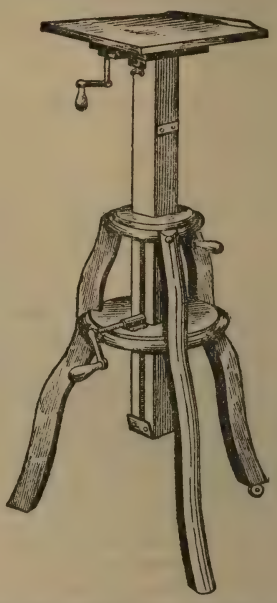
The screw attaching the baseboard of the camera to the head, or top, of the tripod, in those cases when a turntable is not fitted. The loose screw is very liable to get lost, and is difficult to insert without several ineffectual attempts, in which the bottom of the camera frequently gets scratched. Several special forms of tripod screws have been introduced to avoid these objections, among which may be mentioned Renbold's, which is permanently attached to the camera and folds into a recess in the bottom when not in use. It is tightened on the tripod head by means of a nut.

The Royal Photographic Society recommend that all screws fitted to cameras either for attachment to the stand, for fixing rising fronts, or for other movable parts, be either $\frac{3}{16}$ in., $\frac{1}{4}$ in., $\frac{5}{16}$ in., or $\frac{3}{8}$ in. in external diameter, and in pitch of thread and other details in accordance with the generally recognised Whitworth standards for these sizes.

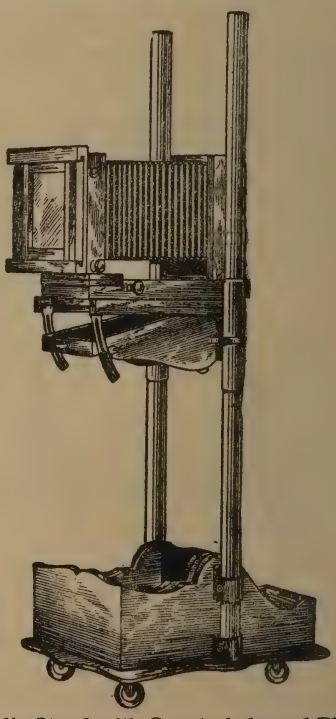
CAMERA STAND (Fr., *Pied;* Ger., *Stativ*)

A raised support for the camera, to keep it steady during focusing and exposure. There are several varieties, differing in construction according to their purpose. In the older but still very common form of studio camera stand B the top is raised or lowered by rack and pinion, or by a counterpoise and weight, while the table has a tilting movement. The better class of studio stand is, however, much more ornate and elaborate (*see* "Studio Camera"). The Hana studio stand C is novel in construction, having a counterbalanced platform travelling on two upright pillars, to which it may instantly be clamped by pulling a lever. Besides the advantages of ease and smoothness of movement, the camera may be raised as high at 7 ft. or lowered to only 2 ft. from the ground. The tripod stand A for field cameras is usually made to fold up, the three legs being then strapped together for carrying.

A. Tripod Stand for Field Camera



B. An Ordinary Form of Studio Stand



C. Studio Stand with Counterbalanced Platform

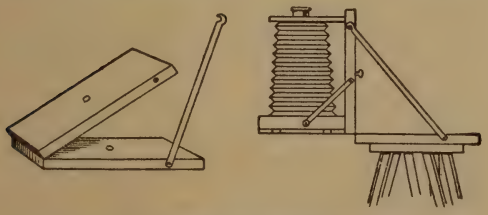
The bottom joint should have a sliding movement to allow of adjustment on uneven ground. The top, or head, is detachable; it is covered

D. Telescopic Stand

with felt to avoid scratching the camera, and it has a hole for the screw by which the latter is secured. Many tripod legs, however, are made to fit a turntable at the bottom of the camera. The tripod head must be sufficiently large for the apparatus which it is to support, or vibration will occur. Steadiness and rigidity should be the distinguishing characteristics of a tripod stand, and should be considered before lightness, though the two qualities are not necessarily antagonistic. Telescopic stands D of brass, steel, or aluminium, are very portable, but are suitable only for light cameras.

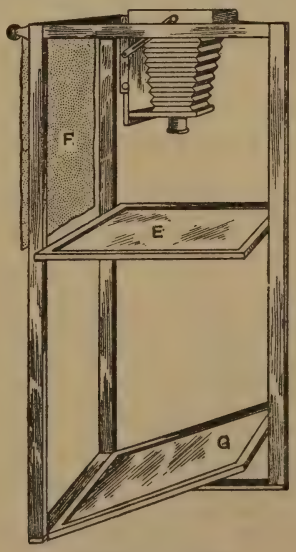
CAMERA, VERTICAL

Cameras are used vertically for the purpose of photographing ceilings, floors, or articles laid upon a horizontal surface. Vertical fittings are



A and B. Hinged and Strutted Table for Vertical Camera

obtainable commercially, but most are home-made. A and B show a very simple arrangement, the exact size of which will depend upon the camera used. The accessory takes the form of a narrow hinged table, which is screwed to the ordinary tripod top, the camera being screwed to the hinged portion, which, in use, is supported vertically by a strut, as shown. The camera can be pointed upwards or downwards in a perfectly vertical position, or, if the strut contains various holes to pass over the screw, at any angle. The late T. C. Hepworth's method (described first in 1894) allows of the camera being pointed downwards but not upwards, and it is largely used for photographing precious stones, medals, illustrations from books, etc. One advantage of such an arrangement (*see* figure C) is that it may be used in an ordinary room against a window, and the subjects will probably be as well lighted as in a studio. This arrangement has been used for photographing a baby lying in a cradle. The camera is fixed at the top end of a skeleton stand; upon the glass platform E can be placed a coloured card, paper, or other medium to serve as a background on which the opaque objects, flowers, etc., may be laid and photographed from above. By employing a glass platform shadows are obviated, and this in some cases is of great advantage, while at the same time it is possible to use at any distance below the glass a background of any colour, which, by screening the light, can be lightened or darkened as may be required. A useful addition is a blind F to shut off all light from the upper surface of the platform; another is a mirror G to reflect the light upwards. By placing a negative upon the glass platform a reduced or enlarged transparency can be obtained more easily than by any other plan. Should the negative be a film it can be kept flat by placing a piece of glass over it.



C. Vertical Camera

In process work, stands holding cameras vertically are frequently used when copying small objects supported on a horizontal surface and these stands are also of advantage when copying from open books.

CAMERON, JULIA MARGARET

Born in Calcutta, 1815; died in Ceylon, 1879. Came to London in 1848, started photography in 1865, and became famous for her admirable portraits of celebrated persons.

CAMPHOR (Fr., *Camphre*; Ger., *Kampfer*)

Common camphor is known also as Japan camphor. A colourless, translucent, crystalline solid with characteristic smell; melts at 175° F. (nearly 80° C.), is soluble 1 in 700 of water, and is readily soluble in alcohol, oils, etc. It is used in the manufacture of celluloid, varnishes, and retouching mediums. Skies may be blocked out of a negative by holding the latter glass-side downwards over a piece of lighted camphor, and wiping away the soot from the parts of the negative it is desired to print.

CANADA BALSAM (Fr., *Baume du Canada*; Ger., *Canadabalsam*)

Known also as Canada turpentine. A resinous fluid, transparent, and of a greenish yellow tint, very viscous, and hardening into a clear transparent solid, whose refractive index is about equal to that of glass. It is obtained from the Balsam Fir of North America, *Abies balsamea* (Coniferæ). In its commercial state it has the consistency of honey; it may be hardened by exposing to the air or rendered more liquid by heating or by the addition of turpentine, ether, or chloroform, but is insoluble in water. It has several uses in photography—for the cementing of lenses together, making varnishes, and rendering paper negatives and prints for the crystoleum process translucent.

In process work, Canada balsam is used for sealing together the two halves of the ruled screens and for sealing colour filters. A further use is for sealing a thin microscope cover glass to the centre of the ground-glass focusing screen, so that a transparent spot is provided for focusing by means of a magnifying eye-piece.

CANARY AND ORANGE MEDIUM

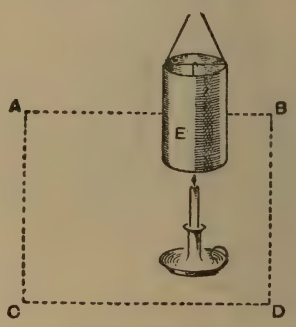
A yellow or orange non-actinic fabric used for screening the light in dark-rooms; yellow paper and glass may also be used in place of the usual red light for some photographic purposes. It is less tiring to the eyes than red and gives more illumination. A yellow light, however, is not safe for modern rapid dry plates and isochromatic plates, but it is admirable for bromide papers and lantern plates. It is more suitable for use with artificial light than with daylight, and when the latter is used two thicknesses of canary medium may be necessary. Orange medium or paper cuts off more green and blue light than canary medium, and allows more orange and red to pass, and it may therefore be used for the slower brands of plates providing the light is not particularly strong. According to Sir William Abney, the total illuminating value of the orange is nearly twice that of the canary.

CANDLE BALANCE (Fr., *Balance à chandelle*; Ger., *Kerzenwage*)

An instrument employed in photometry to ascertain the loss of weight undergone by a candle after burning a given time.

CANDLE-LIGHT EFFECTS

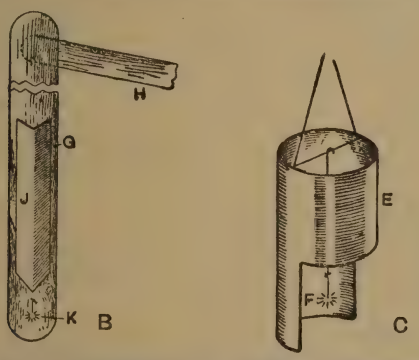
Lighting effects in a photograph, apparently due to the use of a candle as the illuminant. Actually the candle pictured plays no part whatever in the real illumination of the subject. This branch of work was made popular by Newson Gibson, who, during the years 1901 to 1904, produced many remarkable candle-light effects which were puzzling at the time, as it was well known that a candle did not give a sufficiently actinic light for ordinary photography. The secret consists in using a piece of lighted magnesium wire hidden from the lens, but placed as near as possible to the candle flame, so that the light from the magnesium appears to come from the candle, the background immediately above and behind the candle being quite black. A blackened holder supports the magnesium wire above the candle, and is invisible against the black background. Proper arrangements must be made for carrying off the smoke. In the illustration above, A B C D represents the amount of the subject taken in by the lens, the candle being placed as shown and the remainder of the picture being filled with suitable objects. The blackened shield or tube, with the wire behind it, is shown at E, and is lowered until the wire ignites, the smoke escaping up the tube and not showing in the picture.



A. Magnesium Wire Holder Over Candle

Another arrangement B is also recommended by N. Gibson. A strip of wood G 30 in. long and 1¾ in. wide is faced on the side that goes nearest the camera with black velvet; to the top is loosely fastened a long rod H as a handle for the operator, so that the light shield itself hangs vertically, whilst its weight prevents any motion. On the reverse side of the wooden strip is fastened a triangular chimney J made of tinplate, its bottom being about 1½ in. from the lower end of the wooden strip. At the bottom of the chimney the magnesium K is placed, in such a way that the wire may be easily lighted when lowered on to the candle, and the smoke may escape up the chimney and out of the picture. When the magnesium ignites, the shield is raised to expose the flame of the candle and the exposure is made. The long chimney is necessary when the candle is low down in the picture, but when near the top and the smoke has not far to travel a shorter chimney may be used. Another worker uses a platinotype tin, as shown at E, one half at the bottom being cut away and the magnesium wire F suspended from a wire

running across the centre, the whole arrangement being suspended on wire and let down on the candle. It matters little what method is adopted as long as the magnesium is hidden and burned as near as possible in the position of the flame. The flame of the candle must also be kept steady during the exposure. A little daylight may at times be used to light up the dark corners of the room, but it must not be too strong, as the light must appear to come from the candle itself. The necessary exposure can only be found by trial; as a basis for experiment, expose for the whole of the time during which 1 in. of magnesium wire is burning and after it has burnt out allow another second for



B and C. Arrangements for Burning Magnesium for Candlelight Effects

the candle flame, the stop being *f*/11 and the plate extra rapid. The "lamps" described have an effective radius of only 2 ft. or 3 ft., so that subjects must be arranged accordingly.

CANDLE-POWER

The unit for photometric work in England. The light emitted by a standard candle. (*See* "Unit of Light.")

CANDLES, FLASHLIGHT

Magnesium made up in the form of candles with a wick of "touch" material. The commercial candles are of various sizes, burning for and giving exposures up to about half a minute, the most popular being the 2, 4, 7, 12, and 20 seconds sizes. The candles should be kept in a dry place, as otherwise they will burn and splutter badly when fired, and they should be burnt on a metal tray or iron shovel. Serviceable flash candles of a kind may be made at home according to the following formula:—

Magnesium powder	20 parts
Barium nitrate	30 ,,
Flowers of sulphur	8 ,,
Beef tallow (or suet)	7 ,,

Melt the suet or tallow, carefully knead in the other ingredients, place in small metal boxes, mould the top to a point like that of a candle, and fire by means of a torch. They should be burnt on an iron shovel. This preparation gives a good light, and may be used out of doors in large quantities for street work at night, and in small quantities in a room. (*See also* "Flashlight Mixtures.")

CANVAS EFFECTS

Photographs having the appearance of being printed upon canvas. Negatives may be printed upon canvas-grained paper, which is obtainable commercially, or a piece of thin canvas or bolting cloth (*which see*) may be interposed between the negative and the sensitive paper. Negatives for producing canvas effects direct upon the paper may be obtained by exposing in the camera in the ordinary way, and then making a second exposure, this time with the lens focused on canvas, so adjusting the exposures that the grain of the canvas does not predominate over the original exposure. Another method is to make a separate negative of the canvas, and to print from this before or after using the same piece of paper for printing from another negative; this is probably the easiest and most economical method, as the one negative of the canvas may be used for any number of pictures, and the canvas effect printed light or dark over the original print as desired. A good strong sidelight should be used when making a negative from the canvas in order to emphasise the grain. Any suitable fabric may be substituted for the canvas.

In process work, a canvas grain is often imparted to the highly glazed "art" papers used for three-colour printing, so as to give a more artistic effect imitating the painter's canvas. This graining is done by running the paper between a pair of embossing rollers, one of which is steel, bearing the pattern, and the other of paper, to take the impression.

CANVAS, ENLARGEMENTS UPON

Enlargements are made direct upon canvas for the use of artists, either for finishing direct or as a basis for oil-colours. The canvas must first be cleaned with a mixture of 1 oz. of liquor ammoniæ (·880), and 4 oz. of methylated spirit, this being rubbed on with a clean rag or sponge until all greasiness is removed. Three solutions will then be required for sizing, sensitising, and developing.

Sizing

Distilled water	10 oz.	1,000 ccs.
Ammonium bromide	35 grs.	7 g.
Ammonium chloride	10 ,,	2 ,,
Potassium iodide	80 ,,	16 ,,
Gelatine	60 ,,	12 ,,
Dry albumen	1 oz.	100 ,,

Mix and warm the mixture until the gelatine is dissolved, but avoid overheating or the albumen will be coagulated.

Sensitising

Distilled water	6 oz.	500 ccs.
Glacial acetic acid	¼ ,,	40 g.
Silver nitrate	½ ,,	80 ,,

Mix and filter.

Developer

Distilled water	5 oz.	500 ccs.
Lead acetate	5 grs.	1 g.
Gallic acid	30 ,,	6 ,,

The cleaned canvas is sponged over with the sizing mixture as evenly as possible. When dry it is ready for sensitising. Take the canvas into a dark-room, pour over it some of the silver sensitising mixture, and spread evenly with a

pad of cotton wool. Wet or dry it is ready for exposing in the same way as bromide paper, but it is slower than most bromide papers. The developer is applied with the sponge previously used for sensitising, the residue of silver assisting development. The canvas is fixed in a bath of "hypo" 1 oz., water 5 oz., and washed well. During all these processes the canvas may remain on its stretcher.

CANVAS, MOUNTING PRINTS ON

The canvas needs to be strained on a frame. The print or enlargement is placed on a table face downwards, and coated with any good mountant, starch paste being as good as anything. The paste should be rubbed in well with the brush or sponge until the print is limp. Then the stretched canvas is lowered upon it, picked up with the adhering print, and laid right way up on the table. The print needs to be rubbed into close contact, special attention being given to the edges, which may need treatment with a paper-knife.

CANVAS, PRINTING ON (*See* "Fabrics, Printing on.")

CAOUTCHOUC (*See* "Indiarubber.")

CAP, LENS (Fr., *Bouchon;* Ger., *Objectiv-Deckel, Linse Kappe*)

A circular, closely-fitting covering for the lens, lined with black velvet. At one time all exposures were made by taking off and replacing the cap, but for this purpose a shutter is now commonly used. The cap is still, however, often resorted to for time exposures; and caps are generally provided on stand cameras for the protection of the lens, even when a shutter is fitted behind the lens.

CARAMEL (Fr., *Caramel;* Ger., *Karamel*)

A deep reddish-brown, sticky liquid, made by heating loaf sugar. It may be obtained in liquid form from chemists, who call it *saccharum ustum.* It is used in photography as a backing for plates to prevent halation. A rough and ready method of making a small quantity at home is to place loaf-sugar in a dry iron saucepan over a slow fire and stir with an iron spoon. At about 400° F. (204° C.) caramel will be formed, but it requires a considerable amount of care to make it properly, as over- or under-heating will spoil it. The superiority of caramel over other backings is due to its non-actinic colour and to the fact that its refractive index is nearly the same as that of glass. (*See also* "Backings, Plate.")

CARBOLIC ACID (Fr., *Acide phénique;* Ger., *Karbolsäure*)

Synonyms, phenylic alcohol, phenol, phenic acid, and hydrate of phenyl. C_6H_5OH. Molecular weight, 94. It is soluble in water, alcohol, ether, benzine, chloroform, etc.; it is volatile and extremely poisonous, and causes burns on the skin. It is colourless when fresh and pure, but gradually turns pink on exposure to light. It is used to preserve mountants, emulsions, and many other mixtures. It is the starting-point of many photographic chemicals.

CARBON BISULPHIDE (*See* "Carbon Disulphide.")

CARBON DISULPHIDE (Fr., *Sulfure de carbone;* Ger., *Schwefelkohlenstoff*)

Synonym, carbon bisulphide. CS_2. Molecular weight, 76. Solubilities, insoluble in water, soluble in alcohol and ether. Its vapour is inflammable. It is a colourless, highly refractive liquid with characteristic odour, which in impure samples is extremely unpleasant. It is used as a solvent for unvulcanised indiarubber in making rubber solution.

CARBON ENLARGEMENT

An enlargement made by the carbon process. As this process of printing is much too slow for making direct enlargements in the camera, an enlarged negative has to be made, and prints taken from that by daylight in the ordinary manner. For printing in carbon, an enlarged negative should be reversed, so that the print can be made by the single transfer method and still be non-reversed. The most simple and satisfactory manner of obtaining a reversed negative when reproducing or enlarging is to reverse the transparency in the carrier, putting the glass side towards the lens instead of the film. (*See also* "Enlarged Negatives" and "Carbon Process.")

CARBON PROCESS

The idea of the carbon process as it is known to-day is credited to A. L. Poitevin, who, in a patent dated December 13, 1855, describes the action of light upon a chromated gelatine mixed with a pigment. J. Pouncy is supposed to have been the first actually to produce carbon prints, his patent being dated April 10, 1858. In these early processes the half-tones were mostly unsatisfactory, and modifications were made by J. C. Burnett (1858) and Fargier (1860); but it was not until J. W. Swan's improvement in 1864, when he patented carbon tissue, that the process became of any practical use to photographers. J. R. Johnson made further improvements in 1869, and in 1874 the flexible support used in the process was patented by J. R. Sawyer.

The carbon process differs essentially from all other methods of photographic printing. It depends for its working on the fact that gelatine, to which has been added a suitable proportion of an alkaline bichromate, becomes insoluble when exposed to light, but retains its solubility if kept in the dark. A sheet of paper is coated with a mixture of gelatine, colouring matter, and potassium bichromate, and then exposed to daylight under a negative. The portions of the gelatine film that were protected by the high lights or dense parts of the negative retain their solubility, while those that receive the full force of the light through the shadow portions become insoluble. Parts exposed under the intermediate tones become partially soluble. By treating the film with hot water the soluble portions are dissolved away, while the insoluble parts remain, and form the picture. Any colouring matter may be employed, and consequently a picture may be produced in any desired colour.

Carbon tissue is a dark-surfaced paper, the

colour corresponding to the deepest tone that can be obtained in the picture. No visible image is produced by exposure to light, and consequently, the exposure in the printing frame must either be timed or gauged by an actinometer. Carbon tissue sensitised in H. W. Bennett's sensitising bath requires about half the exposure necessary for printing-out silver paper to the full depth necessary for toning, or rather less than the printing-out paper requires to give a visible image resembling a finished result. The prints should be developed as soon as possible after taking from the frame (*see* "Continuing Action"). A piece of single-transfer paper, slightly larger than the exposed print, is also required. The exposed film must be developed from the back, for the reason that the whole of the face has been rendered insoluble, excepting the extreme high-lights, while all the surface in contact with the paper has remained soluble. The film is so thick that the strongest shadow does not penetrate right through. In the deep shadows the insolubility penetrates deeply; in the medium tones there is a moderate thickness of insoluble gelatine, while in the very light parts there is simply a slight superficial insolubility. This layer of soluble gelatine of varying thickness underlying the insoluble image necessitates transferring the film so that the soluble portion becomes the surface. Any attempt to develop the film on its original paper would result in its floating right off as soon as the soluble gelatine commenced to dissolve.

Transferring and developing the exposed print are simple matters. The piece of transfer paper is soaked in cold water until limp. The exposed print is then immersed in cold water for a few seconds, until it begins to become flat, and its face is then brought into contact with the prepared surface of the transfer paper, preferably under water, the two papers brought out together, squeegeed firmly into contact, and then partially dried between blotting-paper under moderate pressure for ten or twelve minutes. The print is now ready for development. It is placed in water that has been warmed to 105° to 110° F. (40·5° to 43·3° C.), and kept below the surface. In about twenty or thirty seconds some of the colour will be seen oozing from the edges. This is the object of the safe edge, to preserve a margin of soluble gelatine; without it the next operation would be impracticable. As soon as the colour is seen to be oozing out, the corner of the paper bearing the film is lifted, and if it comes away easily it is pulled steadily away, leaving the film on the transfer paper. This film is allowed to soak for a few minutes in the hot water, and from time to time the water is gently splashed over it, and it is taken from the water and partially drained. This treatment is continued until the print is sufficiently light, when it is drained thoroughly and then rinsed in cold water to wash off any loose gelatine and colour that may adhere. It is next immersed for about five minutes in an alum bath (1 oz. to 20 oz. water), washed in about three changes of water, and dried. With the exception of the developing bath, all the solutions should be cold. Care must be taken to avoid touching the surface of the film during the working.

An objection to this method of working—the single transfer method—is that the picture is reversed, the left side becoming the right. When it is desirable to avoid this a second transfer is necessary, and the method is known as "double transfer." Instead of using the single transfer paper, a temporary support is substituted (*see* "Flexible Support"). The method of working is exactly the same as described for single transfer, excepting for the preliminary waxing of the support. After development, treatment in the alum bath, and drying the print on the temporary support, it is ready for the second transfer. The drying on the temporary support must not be rapid, and the transfer should take place as soon as possible after drying, or else the print should be kept in a cool place, moist rather than too dry. A piece of final support or double transfer paper is soaked in cold water for at least half an hour, and then the temporary support bearing the print is similarly soaked until quite limp. Both are then immersed in warm water, about 90° F. (32° C.), for about fifteen or twenty seconds, face to face. Then they are withdrawn clinging together and squeegeed into good contact. When thoroughly dry the two papers may be pulled apart, and the image will be firmly and permanently attached to the double transfer paper. The necessity for the second transfer is frequently obviated by the employment of a reversed negative. (*See also* "Carbon Tissue," "Carbon Transfer Papers," "Flexible Support," "Bennett's Carbon Sensitiser," etc.)

CARBON TETRACHLORIDE

Synonym, tetrachloromethane. CCl_4. Molecular weight, 156. A colourless, oily substance, resembling chloroform, volatilising completely without odour, having a boiling point of 170·6° F. (77° C.), and a specific gravity of 1·593 at 68° F. (20° C.). It is obtained by acting upon chloroform with chlorine, and in other ways. It has no action on metals, fabrics or colours, and it is an excellent solvent of shellac, asphalt, fats, etc.

CARBON TISSUE

The paper prepared for printing by the carbon process. It consists of a stout paper thickly coated with a mixture of soft, soluble gelatine and finely ground colour. As gelatine is colourless, any suitable and permanent colouring matter may be employed, and this determines the colour of the print. In preparing carbon tissue, it is necessary that the film should be appreciably thicker than the depth of the strongest shadow of the finished print in order that a thin layer of soluble gelatine should remain between the insoluble shadow and the paper support. Carbon tissue is prepared in two forms, sensitive and insensitive. In the former, a certain proportion of potassium bichromate is mixed with the gelatine and colour when preparing the film; in the latter, the bichromate is omitted, and the tissue requires sensitising by immersion in a bath of potassium bichromate before it can be used.

In process work, carbon tissue is used to a considerable extent, the photogravure process being, for example, solely worked with a carbon resist developed on the copper plate. The special autogravure tissue is generally employed, but some workers prefer the ordinary standard

brown. It is also used as the resist in engraving copper rollers for the rotary intaglio process of printing. It may also be used as a resist for relief grain blocks (an inverted photogravure). In the Government Survey Offices an electrotyping process for the reproduction of maps is worked by developing a carbon print on a silvered copper plate, and then depositing copper on it so as to form a duplicate plate.

CARBON TRANSFER PAPERS

Transfer papers for receiving the film or image in the carbon printing process. Two kinds of such paper are used, called respectively "single transfer paper" and "double transfer paper." The former are those employed when the film or image is transferred from its original paper to one on which it is to remain permanently; the latter are used when the film is transferred to a temporary support for development, and re-transferred to a final support as its permanent basis. Single transfer paper is prepared by coating any suitable paper with gelatine that has been so hardened as to be practically insoluble and impermeable. Double transfer paper bears a thicker coating of soluble gelatine. Both kinds of paper are easy to prepare; any carbon worker can therefore obtain his favourite paper by preparing it himself.

The easiest method of working for the single transfer process is to coat the paper first and harden the gelatine coating afterwards. A solution of gelatine should be prepared, 1 oz. being soaked until soft and then dissolved by heat and made up to about 25 oz. The gelatine solution should be applied to the paper as evenly as possible, by means of a flat brush or a sponge. The brush should be taken first along the sheet of paper, then across, and then diagonally, so as to avoid ridges and to render the coating even. Many workers prefer to give two thin coatings rather than one of medium thickness, the second being applied after the first is quite dry. When the gelatine coating is thoroughly dry it should be hardened by immersing the prepared paper in a solution of chrome alum, 12 grs. to each 1 oz. of water. Three or four minutes should be allowed for immersion, and the paper should then be rinsed in two or three changes of water and dried.

For double transfer a thicker coating of gelatine is required, this being obtained by two or three coatings of the solution given for single transfer; and no hardening solution is employed. Both kinds of paper will keep indefinitely if stored in a dry place. The methods of using are given under the heading "Carbon Process."

The double transfer paper is often used by photo-lithographers as a photo-transfer paper, and is found to be very suitable for this purpose when sensitised with bichromate.

CARBONATE

A salt derived from the hypothetical dibasic acid H_2CO_3, or carbonic acid; for instance, Na_2CO_3 carbonate of soda. Carbonates are of three kinds, normal, acid, and basic; all are decomposed by dilute sulphuric or hydrochloric acid, with the production of carbon dioxide.

CARBOXYLIC ACIDS

Acids derived from the aromatic hydrocarbons by the substitution of one or more carboxyl groups (COOH) for a corresponding number of hydrogen atoms; they are named mono-, di-carboxylic acids, etc., accordingly. Examples are formic and acetic acid.

Hydroxycarboxylic acids are carboxylic acids containing also a hydroxyl group (OH). An example is lactic acid.

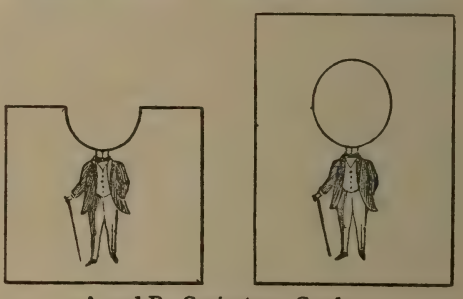
Amido-carboxylic acids contain the amido or amino group (NH_2) as well as COOH.

CARCEL LAMP (Fr., *Lampe carcel;* Ger., *Carcel-lampe*)

A lamp adopted at the Paris Electrical Congress of 1881 as the French unit of illumination in photometry. It burns 42 g. of colza oil per hour, has a flame 40 mm. in height, and gives a light equal to about 9½ standard candles.

CARICATURE (Fr., *Caricature;* Ger., *Zerrbild, Karikatur*)

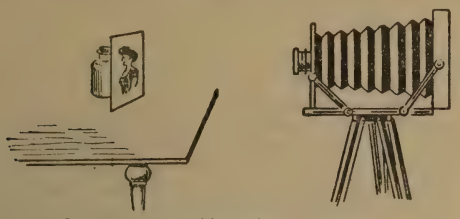
A freak portrait obtained by using special backgrounds and foregrounds, distorting the film, copying, etc. Some of the methods of producing caricatures are described below, and others will be found under such definite headings as "Doubles" and "Trick Photography." *Large heads on small bodies.*—These may be produced in many ways, one of which is to draw the necessary figure, without a head, upon a sheet of



A and B. Caricature Cards

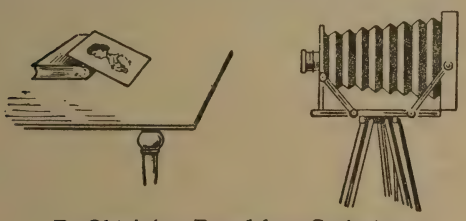
white cardboard, the collar, or neck, being at the extreme top, as at A, or a circle may be cut out for the insertion of the head, as at B. If the former is used, the model sits upon a chair and holds the design under the chin. The background should be of the same colour as the caricature card, and the junction between the two is spotted out so as not to show upon the finished print. An objection to the above plan is that only the head of the sitter is photographed and the following method may be preferable: Two negatives, one of the head of the size required and one a smaller picture of the body, are made; the larger head is cut from the print and pasted over the smaller head in the other picture, the whole being then copied in the camera. *Distorted heads and bodies.*—Distorted images may be obtained by warming a partially dried negative before a fire or over a gas flame, the heat causing the gelatine to melt; the picture can be made to "run," and can be distorted, therefore, to any extent. When dry, the negative can be printed from in the usual way; but,

of course, it cannot be restored to its original state. Another plan is to strip the film from the negative, and to attach it to another glass, stretching it during the process, and allowing it to dry in its stretched position upon the new



C. Obtaining Thin-face Caricature

support. *Broad and long faces.*—Excessively long or broad faces may be produced by the use of convex or concave mirrors. The sitter is posed in front of the mirror, and the distorted image in the glass photographed; but great care is necessary to avoid reflections. Another, and a much easier, plan is to copy an existing and proper photograph; for example, the portrait print is placed in front of the camera, with one edge nearer to it than the other, as in C. The result will be that the width of the face is partly lost, the effect being a lengthening of the face. If an excessively broad face is desired, the print is copied while lying at an angle to the horizontal plane (the less the angle the shorter will be the resulting figure); D shows the idea, the bottom edge of the picture being nearer to the



D. Obtaining Broad-face Caricature

camera than the top edge. Many firms sell specially painted comic backgrounds for making caricatures, also negatives of comic scenes into which the head from any existing negative can be printed.

CARMINE AND CRIMSON TONES

If a negative is of good contrasts P.O.P. prints from it may be toned to a good carmine, as follows: Print and wash as usual, and tone in—

Ammonium sulpho-cyanide	20 grs.	45 g.
Potassium iodide	4 ,,	9 ,,
Gold chloride	1 gr.	2.25 ,,
Water	1 oz.	1,000 ccs.

Toning takes from twenty to thirty minutes, and the tone as well as the time may be altered by varying the amount of iodide. The bath has a slight intensifying action. Any discoloration on the back of the paper and in the high lights will disappear in the fixing bath. Wash and fix in "hypo" as usual.

CARRAGEEN (*See* "Iceland Moss.")

CARRIER (*See* "Camera Carrier," "Plate Carrier," etc.)

CARTE-DE-VISITE (Fr.)

A popular size of professional studio portrait. Size of mount, $4\frac{1}{8}$ in. by $2\frac{1}{2}$ in.; size of print, $3\frac{1}{2}$ in. by $2\frac{1}{4}$ in. or $3\frac{5}{8}$ in. by $2\frac{3}{8}$ in., the latter being "No. 1 C. de V.," and the former "No. 2 C. de V." The carte-de-visite was at the height of its popularity in England in the sixties of the nineteenth century. Its origin was due to a fancy of the Duke of Parma, who, in 1857, had his portrait gummed on his visiting-cards in the place of his name. Ferrier, a professional photographer of Nice, is supposed to have produced the first of this popular size; but it was Disderi, of Paris, the Court photographer to Napoleon III., who made it popular.

CARTON DURA

Hard waterproofed cardboard, formerly used for making photographic dishes. It was made by coating Bristol board with linseed oil, varnish and asphalt, but has now been superseded by papier mâché.

CARTRIDGE FILM (Fr., *Pellicule enroulée;* Ger., *Patronfilm*)

A daylight-loading roll-film, consisting of an emulsion on paper or celluloid, wound on a wooden spool, together with a length of opaque black paper. Cartridge films are used in roll-holders—a kind of dark-slide—and in various forms of hand cameras made to take the films direct. A winding key is employed to pass the film, as exposed, on to another spool. The first roll-film on a paper support was introduced, in 1875, by L. Warnerke, and the first celluloid roll-film in 1889, by the Eastman Company. The non-curling film—that is, a celluloid film with a thin layer of plain gelatine on the back—was placed on the market by the latter firm, now known as Kodak, Ltd., in 1903.

CASEIN, OR CASEINE (Fr., *Caséine;* Ger. *Kasein*)

Solubilities, insoluble in water, soluble in alkalis and organic acids. It is obtained from milk by acidification, and is commonly known as curds. It has been introduced as a vehicle for the silver salts in printing-out paper, as it gives a film which does not become sticky, does not curl up, and is not easily scratched.

In process work, caseine has been advocated for some years past by Prof. Namias and others as a substitute for albumen and fish-glue enamel to form a resist for etching zinc or copper. It has not, however, come into general use. The casein solution is made up as follows:—

Liquor ammoniæ	$3\frac{1}{2}$ oz.
Potassium carbonate	15 ,,
Caseine	$\frac{1}{2}$,,

Allow the whole to stand some hours to dissolve, and sensitise the solution with a saturated solution of ammonium bichromate. The whole is mixed and filtered into a clean bottle, which has to be kept closed. The plate is coated in the usual way, and after exposure under a

negative is inked and then immersed in water. Afterwards it is rinsed without rubbing with cotton-wool. The caseine image is highly resistant to the mordants usually employed, without the necessity of burning-in.

CASEINE PIGMENT PRINTING (Fr., *Tirage en caséine et pigment;* Ger., *Kasein Pigmentdruck*)

A process patented by the Neue Photographische Gesellschaft, in 1908, for obtaining prints in caseine and pigment from bromide or other silver prints. The caseine is employed either in the form of "curd," or in an acid or alkaline solution. In a typical formula, 2,200 grs. of pressed-out curds and 440 to 520 grs. of water-colour are ground together, the mixture being brushed over the bromide print and allowed to dry. The print is then immersed for ten to fifteen minutes in :—

Potassium bichromate	88 grs.	9 g.
Potassium ferricyanide	88 ,,	9 ,,
Potassium bromide	88 ,,	9 ,,
Water to	20 ,,	1,000 ccs.

This has the effect of rendering the pigment-incorporated caseine insoluble at those parts where the silver image is present, the action varying in degree according to the depth or gradation of the latter. The picture may therefore be developed in water at from 105° to 125° F. (41° to 51° C.), after the fashion of a carbon print, a little potassium oxalate or sodium bicarbonate being added to ensure clearness of the lights. The original black silver image fades to a faint brown during treatment, and is practically invisible under the final pigmented picture.

CASKET LENSES

In their original form casket lenses were put upon the market by Darlot, of Paris. His set consisted of a portrait lens (covering 7 in. by 6 in., or with a smaller stop and adjustment of the tube 8½ in. by 6½ in.) and six single achromatic lenses fitting into the same tube, which could be used alone or in pairs, giving fifteen double lenses varying in focal length from 2½ in. to 9 in., each covering a plate whose length is considerably greater than the focal length of the lens. Other makers have since produced similar sets, amongst them being caskets of simple uncorrected "spectacle" lenses for artistic photography. The highest development of the casket idea is found in the Zeiss Satz-anastigmats. These consist of three or four perfectly corrected anastigmatic lenses working at *f*/12·5. The D set gives, in the single combinations, focal lengths of 11½ in. to 19 in., and as doublets four combinations working at *f*/6·3, the focal lengths varying from 7 in. to 10 in. The casket system was very popular some years ago.

CASSETTE (Ger., *Kassette*)

A French term occasionally used in early British photographic works, and meaning the plate-holder or dark-slide.

CASTILE SOAP

A pure soap made from olive oil and soda, and obtainable in two varieties, one a pure white or yellowish white, and the other marbled or veined with bluish-green; the former is the better for photographic purposes. It is used for making encaustic pastes or for waxing glasses to be used for stripping, also, when mixed with methylated spirit, as a lubricator for prints to be passed through a bar burnisher.

CASTOR OIL (Fr., *Huile de ricin;* Ger., *Rizinusöl*)

Solubilities, insoluble in water, soluble in alcohol, ether, and glacial acetic acid. It is a pale yellow, non-drying oil, obtained by expression from the seeds of *Ricinus communis*. It is used in some varnishes and enamel collodion, and to render paper translucent. Also, it is used for temporarily cementing lenses, and as a lubricant.

In process work, castor oil is used in two very useful ways. It is added to collodion to make it more flexible for the stripping process, and it is used for treating the surface of an albumen or fish-glue coating on zinc or copper, so as to cause a negative film to adhere temporarily whilst printing is in progress.

CATALYSOTYPE (Fr. and Ger., *Catalysotypie*)

A variation of the calotype process, invented in 1844 by Dr. Woods, in which the paper is coated with a syrupy mixture containing ferrous iodide instead of with potassium iodide. The coated paper, having been sensitised by brushing over with a silver nitrate solution, is exposed in the camera, and the image either develops itself, or is caused to appear by merely keeping the paper moist. Its name was given under the erroneous impression that the development was due to a catalytic action—that is, a chemical change brought about by an agent which remains itself apparently unaffected. It is now known, however, that this is not the case, since ferrous nitrate, an energetic developer, is produced when the paper is treated with the silver nitrate solution, by the same decomposition that forms the sensitive silver iodide. The process is not very satisfactory, the silver solution being soon blackened by the iron, and the ferrous iodide mixture itself being inconstant in composition.

CATATYPE (Fr. and Ger., *Catatypie*)

A process depending on catalytic action, which is defined in the preceding article. In the original catatype process patented by Messrs. Ostwald & Gros in 1901, a negative image consisting either of silver or platinum is immersed in a solution of hydrogen peroxide in ether, being then withdrawn and the ether permitted to evaporate. The peroxide is decomposed wherever it comes in contact with the metal, but in various degrees according to the different gradations of the picture. The negative so treated is now pressed into contact with a gelatine film for a few seconds, an invisible hydrogen peroxide image being thereby taken up by the latter. If the gelatine film is then immersed in an alkaline solution of a manganous salt, brown manganese peroxide is formed wherever hydrogen peroxide is present, a brown positive image being thus obtained. Or, if an alkaline silver

solution is used instead of a manganous salt, a black image in metallic silver results.

Another method is to place an ordinary negative in contact with hydrogen peroxide, as before, and to bring it for about thirty seconds into contact with a gelatine paper in which a pigment is incorporated, the paper being then immersed in a solution of a ferrous salt. The invisible hydrogen peroxide image taken up by the gelatine will oxidise the ferrous salt to the ferric state, in which it is able to render the gelatine insoluble, the insolubilisation exactly corresponding to the various degrees in which the peroxide is present. The print can then be developed with warm water, as in the carbon process. There are many other variations of the catatype process, mostly patented.

CATECHOL

Another name for the pyrocatechin developer.

CATECHU OR CUTCH (Fr., *Catechou;* Ger., *Katechu*)

Solubilities, soluble in water and alcohol. It occurs in irregular, brittle masses of dark brown colour, slightly porous and glossy when freshly broken; it is an extract obtained from the wood of a species of acacia.

There are several varieties of catechu known in commerce, the principal being ordinary or brown catechu, yellow lump catechu, and cubical or yellow catechu, but all are of practically the same composition. Bengal or Bombay catechu, of the ordinary or brown variety, is the best for photographic purposes, it being rich in tannin. It is of a dark reddish-brown colour with a brilliant fracture, and is almost entirely soluble in water, giving a highly coloured brown solution. It is used for toning platinum prints, the process being known as "Packham's," also for toning blue (ferro-prussiate) prints to a greenish-black colour, the latter being known as Roy's process. (*See* "Blue-print Process.")

CATECHU TONING

A method of toning prints on platinum paper to various shades of brown by means of a solution of catechu was introduced by J. Packham in 1895. The stock toning solution is made up as follows: Place 120 grs. of catechu in 5 oz. of water and boil for five minutes; allow to cool, and then add 1 oz. of alcohol. To make up a working solution add 30 to 40 drops of the stock solution to one pint of water, and heat to a temperature between 130° and 150° F. (54° to 66° C.). The washed black and white platinum pictures are immersed therein, and toning wil be complete in about fifteen minutes, the colour being a rich mellow brown. Within one minute of immersion the prints will probably begin to change, and thereafter pass through various shades of brown in succession; immediately the desired brown is reached, the print is put into cold water which at once stops the toning action. A few minutes' washing completes the operation. When the water with which the toning bath is made contains a considerable amount of lime, the solution becomes pink and slightly stains the whites of the picture. This may be counteracted by adding 2 grs. of potassium oxalate to each pint of the toning bath, the addition tending to give tones of a warmer colour. J. Packham also states that after toning with catechu and washing, the permanency and brightness of the image are aided by immersing the print for about five minutes in a solution of very weak potassium bichromate of a light straw colour. The prints must not be allowed to remain too long in the catechu toning bath, or the whites will be degraded, as the process is really that of staining. If desired, the bath may be used cold, in which case toning is very slow indeed. As the catechu-tannic acid in the catechu combines to form an inky compound with iron, it is important that the latter be entirely removed from the prints before toning.

Chapman Jones has stated that catechu toning is due to the action of the extract upon the iron compound left in the print, which it is difficult, if not impossible, to remove completely, and that other substances which give colours with iron salts would give similar results, though perhaps not such desirable colours. The fact that the image is toned appears to be due to the fact that platinum holds the minute residue of iron more tenaciously than the paper alone, and that the residual iron compound is therefore roughly proportional to the thickness of the platinum deposit. (*See also* "Platinotype Process.")

CATHODAL RAYS (*See* "X-ray Photography.")

CATHODOGRAPHY AND CATHOGRAPHY

Names at one time given to radiography, or, as it is more commonly called, "X-ray" photography.

CATOPTER (Fr., *Catoptron;* Ger., *Katopter*)

An optical instrument in which reflection is made use of; a mirror. A concave mirror was employed by some of the early Daguerreotypists instead of a lens.

CAUSTIC (Fr., *Caustique;* Ger., *Ätz*)

Synonyms, hydroxide or hydrate. Caustic compounds are those in which it may be considered that a metal has replaced one of the hydrogen atoms in water, thus H_2O = water, KHO = potassium hydrate, or caustic potash, NaHO = sodium hydrate, or caustic soda, CaHO = calcium hydrate, LiHO = caustic lithia. They are all powerful alkalis. Caustic potash and soda are used in some developers as accelerators, especially with hydroquinone, but must be employed sparingly as they tend to cause frilling.

CAUSTIC LITHIA (*See* "Lithium Hydrate.")

CAUSTIC POTASH (*See* "Potassium Hydrate.")

CAUSTIC SODA (*See* "Sodium Hydrate.")

C.C.

Cubic centimetre, a measure used in the metric system. The English equivalent is 17 minims (nearly), or ·035 fluid ounce.

C.C. is also used to indicate collodio-chloride paper.

CEDAR OIL (Fr., *Huile essentielle de cèdre ;* Ger., *Zedernholzöl*)

Synonym, oil of red cedar wood. A yellowish, volatile liquid with pleasant odour, obtained from *Juniperus virginia*, and other species of cedar. It is used in microscopy as a clearing agent and with oil immersion lenses.

CELESTIAL PHOTOGRAPHY (Fr., *La photographie astronomique ;* Ger., *Astronomische photographie*)

This is described fully under the heading "Cosmical Photography."

CELLOIDIN (Fr. and Ger., *Celloidin*)

Solubilities, insoluble in water, soluble in a mixture of alcohol and ether. A specially pure form of pyroxyline (*which see*), made by Schering. Usually it occurs in the form of thin, yellowish, transparent shavings.

In process work, celloidin is largely used by those who make up their own collodion. The substance comes on the market either in large dry flakes or in small dry chips, or in chips moistened with alcohol. It is used in the proportion of from 1 to 2 per cent.

CELLS, LENS (*See* "Lenses, Brasswork of.")

CELLS FOR MICROSCOPICAL SPECIMENS

Cells for mounting preserved specimens or sections in glycerine, etc., are made by tracing a circle of Brunswick black on a glass slide and attaching a cover glass.

In the photo-micrography of living objects one of the most convenient materials for cell making is plasticine ; a small piece of this is rolled out between the hands, bent into a circle, placed on the glass slide, and flattened out by pressure with another glass slide, until the cell is of the required depth. The cell is filled with water and the object placed inside ; then a cover slip pressed down keeps the liquid in the cell. Another common form of cell for living objects is an indiarubber ring cemented by Canada balsam or rubber solution to the glass slide, a cover glass being placed on top when the object is in position.

CELLULOID (Fr. *Celluloïde ;* Ger., *Celluloid*)

Solubilities, insoluble in water, soluble in acetone, alcohol, and ether. It is obtained by casting on metal cylinders a viscous solution of pyroxyline (*which see*) in naphtha, amyl acetate, fusel oil, and camphor in varying proportions. This gives the thin sheets used in roll-film cameras, and the thicker strips used in kinematography. Thick sheet celluloid is usually obtained by casting the celluloid in blocks and shaving off to the required thickness. Its principal use is for the support of films of all kinds and for making celluloid varnish or zaponlack.

A great objection to celluloid is its inflammability. A non-inflammable variety (*see* "Cellulose Acetate") has been placed on the market.

A formula for a celluloid varnish is:—

Celluloid or pyroxyline	90 grs.	6 g.
Acetone . . .	10 drms.	35 ccs.
Amyl acetate . .	20 „	70 „
Benzole . . .	20 „	70 „

Old and spoilt films with the gelatine cleaned off will provide the celluloid ; more or less is used to regulate the consistency of the varnish.

In process work, a celluloid varnish made by dissolving celluloid in acetone is sometimes used as a substitute for stripping collodion. The celluloid solution is flowed over the negative, after the application of rubber solution.

CELLULOID, CEMENTS FOR

The best cement for celluloid is a solution of celluloid in amyl acetate or acetone. In joining a kinematograph film, for example, the two ends are scraped thin, lightly coated with cement, and placed between glass plates to dry ; grease on the glass will prevent the pressed-out cement adhering to the glass. Many other cements are available for mending broken celluloid goods. A solution of 1 part of shellac in a mixture of 1 part spirit of camphor and 3 to 4 parts of alcohol (90 per cent.) will answer ; as will also a marine glue consisting of pure indiarubber, shellac, and naphtha. Canada balsam may also be used in the form of a solution in benzine.

CELLULOSE (Fr., *Cellulose ;* Ger., *Zellulose*)

$(C_6H_{10}O_5)_n$. Molecular weight, $(162)_n$. Obtained from the cell walls of plants and usually in the form of cotton-wool, which is the material from which cellulose acetates and nitrates are made.

CELLULOSE ACETATE (Fr., *Cellulose acétate ;* Ger., *Celluloseacetat*)

$(C_6H_{10}O_5)_n$ 3COOH. This is obtained by the action of acetic anhydride on cellulose, usually in the form of cotton or cotton-wool, in the presence of glacial acetic acid and some condensing agent such as sulphuric or phosphoric acids or acetyl and zinc chlorides. The cotton may be mercerised or not, or previously converted into hydrocellulose, or the hydrolising may be effected in the acetylising bath. It occurs as a granular powder of white or faintly yellowish colour, or in the form of the original cellulose itself. It is of special interest, as it forms the basis of the non-inflammable celluloids that have been placed on the market. Films prepared with it fuse and char, but will not burn. It is insoluble in alcohol and ether, and nearly all the solvents of pyroxyline, but soluble in phenol, tetrachlorethane and alcohol, acetone and alcohol, etc.

CELLULOSE NITRATES (*See* "Pyroxyline.")

CELLULOTYPE

Etching on celluloid with the needle point for intaglio printing.

CELLUTYPE

Printing blocks cut in celluloid with the object of superseding woodcuts.

CELSIUS THERMOMETER (*See* "Thermometer.")

CEMENTS (*See* "Mountants" and various substances, "Ebonite," "Glass," etc.)

CEMENTING LENSES (*See* "Lenses, Cementing.")

STILL LIFE

A photograph in natural colours, taken on the Dufay Dioptichrome place, and reproduced by the four-colour process

CENTIGRADE THERMOMETER (*See* "Thermometer.")

CENTIGRAM, CENTIMÈTRE, CENTILITRE, ETC. (*See* "Weights and Measures.")

CENTRAL SPOT (*See* "Flare.")

CENTRE OF ADMISSION (*See* "Nodal Points.")

CENTRIFUGAL SEPARATION (Fr., *Séparation centrifuge;* Ger., *Separiren mittels einer Zentrifugalmaschine*)

A method introduced by Plener in 1881 for separating the sensitive silver salts from the gelatine used during the manufacture of emulsions. The fluid emulsion is poured into a gunmetal receptacle, which is rotated at a speed of from 4,000 to 6,000 revolutions a minute, the silver salts being thrown on to the walls of the container, whilst the gelatine and water escape by an orifice at the bottom. It is claimed for this method that the emulsion is very rapidly freed from the nitrates, formed as by-products, and the decomposed gelatine. The method has fallen into almost complete desuetude.

CENTRING OF LENSES

When a lens is correctly centred the axes of all its surfaces are in a straight line; otherwise, good definition cannot be obtained. Faulty centring gives a distortion to the image similar to that of astigmatism or coma, and is easily detected by fixing the lens upon a camera or optical bench and focusing a brightly illuminated object, such as a small lamp flame or mercury bulb. The position of the image is carefully noted, and the lens gently rotated in its flange, when, if the centring be perfect, the image will remain quite stationary, but if not it will move in more or less of a circular direction upon the screen. The fault may be in the flange, or rather the body ring of the lens tube, or it may be in the thread upon the lens cells, in the cementing of the separate components, or the surfaces of one or more of the single glasses of the combination may not be correctly adjusted. In any case, it is a matter for an experienced optical workman to put right.

The centring of the actual components of the lens is a simple process, but one requiring considerable skill. When a lens leaves the polisher's hands it has a more or less rough edge, and is a little larger than the cell it is destined to fit. It then goes into the hands of a workman for "edging" and "centring," which operations are performed simultaneously. The lens is stuck with pitch upon a revolving chuck, and a gas flame is so adjusted that two images of it are seen by reflection from the inner and outer surfaces of the lens. These will be found to "wobble" as the lathe head rotates, and the workman slides the lens upon the soft pitch until they are quite steady. The pitch is then allowed to set and the edge of the lens is ground to correct size upon the lathe by the application of a copper plate fed with wet emery powder. A similar process is gone through after cementing two or more glasses together while the balsam is sufficiently soft to allow the surfaces to be moved upon each other.

CERAMIC PAPER

A paper at one time used for the production of ceramics; invented by Guerot in 1891. It was sensitised with a solution the constituents of which were kept a trade secret. The paper was printed upon, washed, squeegeed in contact with the vitrifiable plaque, and stripped. The image was then treated with a solution of potassium permanganate, washed, dried, and finally fired.

CERAMIC PROCESS

The art of obtaining a burnt-in impression of a photograph on earthenware, china, or porcelain. Such pictures are permanent because the image, formed by a vitrifiable powder, is protected by an imperishable glaze. The material of which the picture is composed must obviously be of a special nature. The process is based on the dusting-on or powder process, in which a bichromated film loses its tackiness in different degrees by exposure to light under a negative, so that on brushing it over with a suitable powder an image is obtained; but in ceramic photography the powder used is a vitrifiable colour which stands firing without injury.

The transparency used must be bright, vigorous, and of the highest quality. The image for firing is not produced at first on its final support. A polished glass plate forms a temporary support, the print obtained on it being afterwards coated with collodion, stripped and transferred. The glass plate is cleaned and coated with a mixture of the following two solutions:—

Organifier

Le Page's fish-glue	2 oz.	62 g.
Glucose	8 ,,	248 ,,
Glycerine	20 mins.	1·2 ccs.
Water	21 oz.	600 ,,

Sensitiser

Ammonium bichromate	900 grs.	58 g.
Water	21 oz.	600 ccs.

If a smaller quantity is desired, keep to the same proportions. Mix together in equal parts and filter as required. Such solutions may be purchased ready prepared. The coated plate is dried by gentle heat, not greater than that which can be borne comfortably by the back of the hand. A whirler is useful for rapid drying. A thin, even coating should be aimed at, and the film ought to be quite glossy when dry. The exposure under the transparency varies with the quality of the latter and the light, and it is better to use an actinometer; it may range from forty seconds to three minutes in the sun, or to as much as fifteen minutes in diffused light. With a correct exposure the image will be faintly visible on the film. Development is performed as in the dusting-on process (*which see*), but the plate is held in an inclined position resting on a sheet of white paper, sensitive side towards the light, so that progress may be viewed by both transmitted and reflected light; and vitrifiable powders must be employed. These consist of metallic oxides and other fusible substances, and they are obtainable in a number of

different tints. Sift the powder through silk, but it may be necessary, before doing this, to re-grind it with water, using a muller on a glass slab. The powder must be thoroughly dried before sifting. Firing alters the colours of the powders to an extent that only experience will show. When the image possesses about the same vigour and transparency as a good lantern slide, the surplus powder is dusted off, and the picture coated with collodion (either plain or a special preparation), which is flowed over the plate like a varnish. When the collodion has set, a sharp penknife is pressed downward through the edges of the film on three sides of the plate, cutting through to the glass; the plate is then immersed in several changes of water, preferably filtered, to remove the bichromate salt. The film will separate from the plate, except on one side. When the bichromate seems nearly all removed, the film is placed in a solution of fused borax for about ten minutes, finally washing in a fresh bath of filtered water for an equal period. To prepare the fused borax solution, place 2 oz. of the fused borax in an enamelled saucepan with water, boil rapidly for five minutes, decant, add fresh water, and repeat until all the borax is dissolved. For use, take three parts of the saturated solution (cold) and add one part of water. For transferring, fill a large basin or dish with the borax solution. The plate, after its final washing, is stood in a rack for a few minutes to drain off the surplus moisture. The penknife is then very carefully passed along the fourth edge of the film, which must not be cut through by drawing the blade along, as that would pucker or tear the film. The plate is now placed in the basin, and the film will float off the glass, which can then be withdrawn. With a camel-hair brush turn over the film in the solution so that the collodion side is downward; if the fingers were used there would be a risk of damaging the loose film or of abrading the powdered side. The plaque or other support is next introduced under the floating film, which is guided into its correct final position. The support is then slowly, and by degrees, lifted out of the water with the film adhering, powder side uppermost, and placed on blotting-paper to dry, after which loose pieces of film may be removed with a damp sponge, and the image should be very carefully examined for any black spots or imperfections, the former being removed with a fine needle-point set in a wooden handle. The delicate powder is next protected by flowing over it—

Fatty oil of turpentine . . .	10 mins.	20 ccs.
Oil of turpentine .	1 oz.	1,000 „

Oil of turpentine oxidises by exposing for some time to light and air. The mixture should be filtered and kept from the dust. When dry, the plaque coated with this medium should appear uniformly dull. Any white spots on the picture may now be filled in with a little of the powder colour mixed with the medium above mentioned. If the plaque is given a light firing, just sufficient to attach the powder to the surface, it can be spotted or worked upon with facility.

Firing is the next process. The work will be fired at any pottery for a moderate charge; but by the aid of a gas muffle the worker can easily do his own. For tiles and plaques the heat must be applied very carefully, gradually increasing the consumption of gas. When the furnace is fully heated the gas is immediately turned out, the chimney covered up, and the whole left to cool, or, instead, the work can be transferred to an annealing chamber. Enamel plaques or medallions on a metal base need not be cooled with such extreme care.

Dust is especially to be avoided in ceramic work; it is advisable to sprinkle the floor of the room with water, which will probably suffice to lay the floating dust, and on no account should any sweeping or dusting be done immediately preceding any of the manipulations. Charging the air with moisture by means of a spray diffuser or vaporiser prevents the dust nuisance, but makes the room too moist for developing.

It may be said that the image may be printed direct on perfectly flat surfaces, instead of using a temporary support.

There are many possible modifications of the above process. (1) Instead of using the dusting-on process, a film prepared with ferric chloride may be employed. The film is exposed under a negative to obtain a plate of various degrees of tackiness, which is then brushed over with powdered enamel colour as before. No transparency is required. The picture so obtained is coated with collodion, stripped, and treated as before described. (2) Prints obtained by the carbon process, simply substituting enamel colours in the preparation of the film, may be developed upon porcelain as a final support, forming excellent pictures for firing. (3) A method that is useful where numbers are required is to obtain a photo-mechanical impression in the usual manner on a special transfer paper prepared with a collodion substratum. A suitably tacky ink is used for printing, and the ceramic powder is dusted over this. The paper is then moistened and removed, while the film and picture, collodion side downwards, are transferred to the porcelain support or plaque, which is first treated with an adhesive medium. (4) The following procedure may be taken as representative of the substitution process. A collodion positive is obtained in the camera by the wet process, fixed, washed, bleached in a 5 per cent. solution of mercuric chloride, again washed and placed in the substitution bath, which is to replace the original image, unsuitable for firing, with one of platinum or iridium. A gold and platinum bath, as follows, gives a purple-brown colour:—

Potassium chloroplatinite . .	8 grs.	1.5	g.
Gold chloride (1 in 60)	4½ drms.	43	ccs.
Water (distilled) .	4½ oz.	345	„
Lactic acid . . .	5 mins.	·9	„

An iridium and gold bath gives a warm black tone:—

Iridium chloride .	8 grs.	1.5	g.
Gold chloride (1 in 60)	4½ drms.	43	ccs.
Water (distilled) .	4½ oz.	345	„
Lactic acid . .	6 mins.	1	„

After the deepest shadows of the picture have been toned through, wash for a few minutes to

remove the free toning solution. Cut round the margins of the film, immerse the plate in a 1 per cent. solution of sulphuric acid, wash the film after it strips off, transfer to the final support of porcelain, collodion side up, and dry. Then remove the collodion film by gently rubbing with a sponge moistened with ether and alcohol, again dry, and dust the image with flux, when it is ready for firing. (5) It is possible to obtain a burnt-in picture in natural colours by the exact superposition of a blue, a red, and a yellow picture printed from three negatives obtained through suitable screens. The yellow film is first transferred and fired, allowed to cool, and the blue image very carefully superposed on this in exact register and burnt in. After again cooling, the red film is transferred and fired.

CERATE PASTE

A paste or waxy mixture for surface application to finished prints. Better known as encaustic paste, under which heading formulæ will be found.

CERIC SULPHATE (Fr., *Sulfate de cérium, Sulfate cérique;* Ger., *Cerisulfat*)

Synonym, sulphate of cerium. Solubilities, slightly soluble in water, more soluble in dilute sulphuric acid. $Ce(SO_4)_2\ 4H_2O$. Molecular weight, 404. It occurs as reddish yellow crystals, and was suggested by Lumière as a reducer, the formula being:—

Ceric sulphate	.	2 oz.	100 g.
Sulphuric acid	.	384 mins.	40 ccs.
Distilled water to	.	20 oz.	1,000 ,,

This acts very energetically, and can be diluted for prints and lantern slides. A 5 per cent. solution acts more strongly on the high lights of a negative than the shadows.

CERIO PRINTING

A term commercially applied to the kallitype process (*which see*).

CERIUM SALTS, PRINTING WITH

There are two series of cerium salts, a cerous and a ceric, the former being stable, but the latter extremely unstable; this fact induced Lumière and Seyewetz to examine their photographic properties, and they found that ceric sulphate and nitrate, when used for sensitising gelatinised paper with exposure under a positive, were reduced to the cerous state, and became pale coloured. The print, being then treated with certain organic substances, gave coloured images, due to the formation of dyes through the oxidation of the developers by the unreduced ceric salts, and the dye images thus formed were insoluble in water. In an acid solution phenol gives grey images; aniline salts give greens; naphthylamine gives blue; amidobenzoic acid, brown; parasulphanilic acid, red; and ortho-toluidine salts, brown images. With ammoniacal solutions other colours are obtained; for instance, aniline gives violet and naphthylamine reddish violet images. Paper sensitised with these cerium salts is far more sensitive than with iron or manganese salts and the range of colours is far greater, but no commercial application of this process has yet been made.

CEROGRAPHY

The art and process of engraving on wax. (*See* "Wax Engraving.")

CEROLINE (Fr., *Céroline;* Ger., *Ceroline*)

A solution of white wax in benzole, used in the early days to render paper translucent.

CERTINAL

A highly concentrated liquid developer in one-solution form, introduced by Ilford Ltd., March, 1909. The best proportion for developing plates and films which have received normal exposure is certinal 24 drops, water 1 oz. At a temperature of 60° F. (nearly 16° C.) the image appears in a few seconds, and development will be complete in from 4 to 8 minutes, according to the plate and the class of negative desired. The rapid appearance on dry plates must not be mistaken for signs of over-exposure, and the image will need to be developed for density. As a rule, the image on a properly exposed plate appears in 15 seconds, and development is complete in 6 minutes. With under-exposure the best results are obtained by using the developer weaker (16 drops of certinal to each ounce of water) and developing longer. Over-exposed plates need a stronger developer and the addition of potassium bromide (certinal 48 drops, water 1 oz., 10 per cent. solution of bromide 48 drops); development will then take about one-fourth less time than would be required when exposure and developer are normal. For tank or stand development ¼ oz. (120 drops) of certinal should be added to 25 oz. of water; development will be complete in from 30 to 60 minutes, according to temperature, plate, subject, and type of negative desired. For lantern plates and bromide paper the best strength is 16 drops to each ounce of water, but gaslight papers and plates need double that strength. More contrast may be obtained on papers and lantern plates by using a stronger developer, and still more by adding potassium bromide, while softer results are obtained by diluting the developer. Additional bromide gives warmer blacks, especially on gaslight papers and plates.

CHALK (Fr., *Craie;* Ger., *Kreide*)

Precipitated chalk, a fine white substance, is a pure form of carbonate of lime. It is often used for neutralising gold toning baths, for which purpose common whiting (prepared from chalk by grinding and levigating) is sometimes used; chalk is also used for clearing varnishes.

In process work, precipitated chalk or washed whiting is largely used for cleaning glass, for giving a final polish to copper and zinc plates, so as to remove grease (the chalk being made into a paste with ammonia), and for rubbing in an engraved plate, so that the image may show up and enable the engraver or fine etcher to do any retouching that may be required. Magnesia is, however, more generally used now for the latter purpose, the chalk often tending to grittiness.

Lithographic chalk is somewhat a misnomer, this substance being the black, greasy, crayon used for drawing on grained lithographic stone, zinc, or aluminium, and for drawing on grained transfer papers. The term no doubt originated

from the similarity of the crayons to ordinary black and white chalks used for drawing on paper.

Chalk ink is a stiff black lithographic ink used for inking-up lithographic drawings in chalk on grained surfaces.

Chalk transfer paper is a grained paper for drawing upon with lithographic chalks.

CHALK, FRENCH (Fr., *Talc, Saron à marquer;* Ger., *Talk, Französische Kreide*)

Synonyms, talc and steatite. French chalk is a hydrous silicate of magnesia, a typical analysis being: silica 62, magnesia 33·1, and water 4·9 per cent.; 1 or 2 per cent. of iron often occurs as well. It has the appearance of a fine white or greyish white powder, and is used chiefly for polishing glass, to which prints are squeegeed for the purpose of glazing.

In process work, it is used for polishing glass for stripping purposes, and also as a resist for etching, for which latter purpose it is dusted upon an ink image. It is especially useful in this way in lithographic work on stone, and it is sometimes employed in admixture with black-lead.

CHALK PLATE

An iron plate thickly coated with a chalky substance, through which a drawing is scratched with a pointed stylus. The plate is then used as a matrix for stereotyping.

CHALKINESS (NEGATIVES AND PRINTS)

"Hardness" or excessive contrast; chalky negatives and prints show a very great difference between the high lights and deep shadows. The fault is due to under-exposure and over-development, and a partial remedy is the ammonium persulphate reducer. Softer prints may be obtained from such negatives by bleaching with, say, a mercuric bichloride solution as used for intensifying, and printing from the negative in its bleached or whitened condition. There is no complete remedy for chalky or hard prints.

CHALKINESS (WATER)

Water, particularly hard water, is sometimes chalky, and although it rarely does any harm to solutions it is better to boil it before use (*see* "Water"). Dr. Hauberisser has described a chalkiness which comes over the negative in a kind of fog, and is due to impurities in the water, these giving rise to an insoluble calcium compound. When water containing not only sodium chloride, but a calcium salt as well, is used, there is the risk of calcium oxalate being formed should a ferrous oxalate developer be employed. Similarly, with water containing organic agents, the use of potassium carbonate may cause calcium carbonate to be precipitated as a sediment in the gelatine, thus producing a calcic fog. A simple remedy for such a deposit consists in the application of a weak solution of hydrochloric acid to the negative, this converting the calcium carbonate to soluble calcium chloride, which, of course, washes out. There may, however, be a risk of the liberated carbon dioxide causing blisters.

CHANGING BAGS AND BOXES

A changing bag is a device to allow of reloading dark-slides or sheaths without the necessity for a dark-room. It is generally a bag of several thicknesses of black and red material, provided with sleeves which tighten round the arms by means of elastic, so that the hands are inside the bag. In some forms the changing has to be effected by the sense of touch alone; in others there is an eye-piece to fit on the face so that the interior of the bag can be seen, light being admitted through a panel of red fabric or celluloid in one side of the bag. The utility of such a bag as a makeshift dark-room is obvious.

A changing box is a magazine holding plates in sheaths, and is generally detachable from the camera. An exposed plate can be moved from the front to the back, or an unexposed plate taken from the back and placed in front of the one last exposed. The usual method of accomplishing this is to raise the plate into a bag of flexible leather and place it in position by hand, but in some cases the transfer is made mechanically. The front of the changing box is fitted with a draw shutter, which is opened for exposure and closed when the box is to be removed from the camera. The back of the box can be opened for the removal of exposed plates and for reloading the sheaths. Hence there is some advantage in those types in which the exposed plates find their way to the back of the box, as they may be removed without disturbing unused plates. Many boxes are constructed to take cut films instead of plates, their capacity thus being doubled. Obviously the number of plates or films available may be increased by the use of additional changing boxes. (*See also* "Daylight Changing.")

CHARBON VELOURS (Fr.)

The name originally given to the paper introduced by V. Artigue, of Bordeaux, in 1892 (*see* "Artigue Process"). A recipe for making a similar paper is given under the above denomination by H. Schneeberger. The pigment may be any ordinary water-colour; or moist colours may be used, provided they do not contain a tanning ingredient. The colour is rubbed up in a stiff paste of starch and applied to the paper in a thin uniform coating. Too thin a coating, or one containing insufficient pigment, does not give the desired velvety appearance; while, if too thick, the half-tones and other parts where the light has not penetrated to the support are apt to wash away in developing. The coated paper will keep indefinitely. It is sensitised, for flat negatives, in a 2 per cent. bath of potassium bichromate, or, for hard negatives, in a 5 per cent. bath. Development is with a warm sawdust mixture, as in the Artigue process, a temperature of about 80° F. (about 27° C.) being recommended.

CHARCOAL, ANIMAL

Known generally as bone black (*which see*).

CHARCOAL, WOOD (Fr., *Charbon de bois;* Ger., *Holzkohle*)

Wood charcoal is the residue from the destructive distillation of wood. Wood having been heated to a high temperature out of contact with

the air, the volatile portions are driven off, and the yield is very nearly pure carbon. Sticks of charcoal made from vine or willow wood are used as crayons for working up enlargements.

In process work, blocks of charcoal are used for polishing the metal plates. Formerly, selected sticks of willow charcoal were used, but of late years this has been superseded by charcoal made of trimmed blocks of soft pine. Such charcoal comes from the United States, and is known as "American charcoal." It is beautifully soft and even in texture, and can be had in "hard" and "soft" qualities.

CHARDON'S PROCESS (Fr., *Procédé Chardon;* Ger., *Chardon's Prozess*)

A collodion emulsion process due to Alfred Chardon, who won with it the prize of 1,000 francs offered jointly, in 1876, by the Photographic Society of France and A. Liebert, of Paris, for the best and most reliable dry process for outdoor use. It was, as its author stated, more a well-judged selection and combination of the best points of other processes than an original or new method, although possessing some novel features: as the use of two different kinds of precipitated pyroxyline; washing the emulsion by pouring it into the water, instead of the reverse, as was formerly done; the employment of glucose in the developer to obtain density, etc.

CHEMICAL FOCUS (Fr., *Foyer chimique;* Ger., *Chemischer Brennpunkt*)

The plane on which the actinic rays are brought to a focus. In simple periscopic or non-achromatic lenses, the focal plane for the actinic rays lies nearer the lens than that of the visual rays; it follows, therefore, that the sharp image obtained by focusing, which is affected by the visual rays, is not reproduced by the sensitive film on which the actinic rays act most. This defect, which is rarely met with now, can be remedied either by reducing the distance between the lens and plate, after focusing and before exposure, by from $\frac{1}{30}$ to $\frac{1}{60}$ of the extension of the camera, or by the temporary insertion, only whilst focusing, of a weak supplementary lens which reduces the focal length.

CHEMICAL FOG (*See* "Fog.")

CHEMICAL RAYS (*See* "Actinic.")

CHEMICAL RETOUCHING (*See* "Retouching, Chemical.")

CHEMICALS

A list of the chemicals used in photography, with their formulæ and solubilities, appears under the heading "Solubilities."

CHEMICALS, STORING

Chemicals need careful storing if they are to be kept good and in a proper working condition. Those given below are the chemicals mostly used in photography, and the remarks apply generally to the chemicals themselves, as bought, and not to made-up solutions, as developers, intensifiers, etc., for information as to which *see* under the heading "Solutions." Photographic chemicals may be divided into four classes—namely:—

(1) Chemicals that keep well and need no special precautions, other than being stored in a dry place:—

Alum (ordinary and chrome)	Potassium bichromate
Borax	Potassium bromide
Boric acid	Potassium ferricyanide
Caramel	Potassium oxalate
Citric acid	Sodium acetate
Mercuric chloride	Sodium carbonate
	Sodium hyposulphite

(2) Chemicals that must be kept in bottles with tight-fitting corks (not glass stoppers) because of their deliquescent nature or oxidising properties:—

Adurol	Magnesium powder
Amidol	Potassium carbonate
Ammonium carbonat	Potassium cyanide
Ammonium sulphocyanide	Potassium hydrate
	Potassium iodide
Eikonogen	Potassium metabisulphite
Ferric chloride	
Ferrous sulphate	Pyrogallic acid
Formosulphite	Sodium hydrate
Glycin	Sodium sulphate
Hydroquinone	Sodium sulphite
Metol	Uranium nitrate

and all other dry developers not mentioned above, as metoquinone, pyro-catechin, etc.

(3) Corrosive and volatile substances, which should be kept in bottles having accurately ground glass stoppers, not corks:—

Acetic acid	Collodion
Acetone	Ether
Alcohol	Formaline
Ammonia (liquor)	Hydrochloric acid
Ammonium persulphate	Iodine
	Nitric acid
Amyl acetate	Sulphuric acid

(4) Materials that should be kept in a dark cupboard, or in black bottles when not in use:—

All kinds of liquid aniline dyes.
Gold chloride in solution.
Potassium chloroplatinite in solution
Silver nitrate, dry and in solution.

Chemicals that are poisonous, or otherwise dangerous, should be stored in a cupboard or some out-of-the-way place where they cannot be got at by persons unacquainted with their dangerous properties. Such chemicals include:—

Acetic acid	Sodium oxalate
Hydrofluoric acid	Chromic acid
Nitric acid	Hydrochloric acid
Chrome alum	Sulphuric acid
Ammonium bichromate	Ammonia
	Ammonium oxalate
All soluble barium salts	Bromine
	Formaline
Soluble copper salts	Lead acetate
Lead nitrate	Potassium oxalate
Potassium bichromate	Caustic soda
Caustic potash	Sodium bichromate
Silver nitrate	All developers

These are in addition to the scheduled poisons, all of which must be kept in a safe place.

CHEMIGLYPHY

Another name for "Glyphography" (*which see*).

CHEMIGRAPHY

A general name, not often used now, for zinc etching. (*See also* "Chemitype.")

CHEMITYPE

Before the application of photography to zinc etching, lithographic transfers or drawings direct on zinc were etched into relief for letterpress printing. This process was generally called "Chemitype" or "Chemigraphy."

CHIAROSCURO (It.)

A word adapted from the Italian *chiaro*, clear, and *oscuro*, dark, and indicating the light and shade in a picture. The suitable placing of the highest light and the deepest shadow is of great importance. Scattered high lights and disjointed shadow masses are fatal to harmonious effect. The portraits of Rembrandt are good and familiar examples of effective knowledge of the value of proper chiaroscuro.

Chiaroscuro is the name of a class of colour prints in which the varying effects of light and shade are represented, not by lines or cross-hatching, as in ordinary engraving on wood or metal, but by tones in the shape of broad masses of colour, produced by surface printing from wood-blocks. These were usually employed for the purpose of colouring an outline woodcut.

CHILDREN, PHOTOGRAPHY OF

The success or failure in photographing a child is nearly always dependent on the ability of the operator to gain the confidence of his juvenile sitter. In the case of amateur work, the child is often personally acquainted with the photographer, but in professional work the child is probably a complete stranger to the operator. It is useless to treat a child in the same manner as an adult, and simply request it to assume the desired position. Particular art is necessary in getting the child to adopt the pose required. Too many friends of the child should not be allowed into the studio, one being quite enough; otherwise difficulties are likely to ensue, especially in the case of very young children whose attention is very easily diverted. Children differ so much in their disposition that it is possible to make friends easily with some, whilst others are shy and require quite diplomatic handling. In some cases it is better to ignore the child at first, and to engage in conversation with whoever is in attendance on the child, and then, by opening a picture-book, operating a mechanical toy, introducing a dog or cat, the child becomes interested and gradually its confidence is won. Some of the most successful child photographers have cultivated an ability to bring themselves down to the children by playing games and in other ways giving them the impression "that they are one of themselves." By this means they engage a child's attention, until both the desired position in the studio and the happy expression are attained, at which juncture an assistant makes the exposure.

The introduction of modern high-speed plates has given new possibilities to child photography. Some few years ago it was necessary to draw up all the studio blinds so as to admit as much light as possible, but although this allowed a quicker exposure to be made, the picture was devoid of all light and shade gradations. The plates at present available allow of a more subdued light being used; and proper attention should be given to the arrangement of blinds for controlling the lighting.

The studio reflex camera is at present but very little used, but for child photography it possesses very great advantages, as it frequently happens that when the child has been correctly focused and the dark-slide inserted for exposure, the child moves to some other position, necessitating re-focusing. With a reflex camera this trouble is avoided, as it is possible to focus the sitter right up to the moment of exposure.

The dress of the child often makes or mars a picture, and some photographs owe their charm almost entirely to dainty garments. On the other hand, quite young children usually make more pleasing pictures when photographed either nude or with only a single garment on.

Amateur work takes place under varied conditions, some workers possessing lofty rooms with abundant light in which it is possible to obtain pictures equal to those produced in a studio; but for those not so fortunate special arrangements must be made so as to obtain sufficient light for the quick exposures necessitated. In an ordinary room with a bow window it is often an advantage to take away all existing blinds and hangings, as these, when drawn up or to the side, frequently cut off much light. The window-panes may be covered with tissue paper, as this gives a more equal diffusion of light; on the shadow side a screen should be used with a sheet thrown over it for use as a reflector, but care must be exercised not to move this reflector too close to the child, otherwise too flat a lighting is obtained, and there is great risk of producing false lights in the eyes. As children are usually taken so as to show the entire figure, it is necessary to see that the lighting reaches well down to the ground; to accomplish this it is sometimes useful to build up a platform some 12 in. or 18 in. from the floor. Care must be taken to prevent the light coming too much from the side, and so to arrange the light that the strongest portion of it falls from a point higher than the child's head. This can be attained by covering the lower panes of the glass with three or four thicknesses of tissue paper. In photographing children out of doors, good lighting is possible if care is taken to choose a position where the light is screened from one side; this is easily done by utilising the side of a house and arranging the sitter near to it, so that the main direction of light falls from the side and front. If a head screen is available it should be used to cut off the immediate top light. An entrance doorway or portico is very often suitable for such portrait work. (*See also* "Home Portraiture," "Studio Portraiture," etc.)

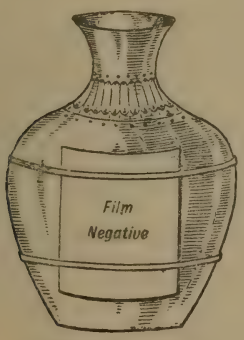
CHINA CLAY (*See* "Kaolin.")

CHINA, PHOTOGRAPHS ON

There are several methods of printing photographs upon china, crockery, opal, etc. For objects where the picture is to be viewed by reflected and not transmitted light, the carbon process (*which see*) is perhaps the best; tissue of

any colour may of course be used, and the picture, after being printed upon the tissue, is transferred and developed upon the china support, after the latter has been properly prepared with a suitable substratum. By this process it is an easy matter to transfer photographs upon curved surfaces. The ceramic process (*which see*) is more difficult, but the results are absolutely permanent and will permit of any amount of washing.

The blue-print (ferroprussiate) process is simple, and is often employed for producing pictures upon china and glass. It will be necessary to give the article a coating of gelatine to serve as a vehicle for holding the sensitive solutions, the blue-print being a direct printing and not a transferring process, as carbon. A suitable gelatine substratum may be made by soaking 22 grs. of Nelson's No. 1 gelatine in 1 oz of water and melting by the aid of heat, afterwards filtering while hot. The solution, when warm (130° F. or 54° C.), is coated as evenly as possible upon the part of the article to be printed upon, and then set aside to cool. The prepared part is then sensitised as if it were paper, and when dry it is ready for printing upon.



Printing on Vase

Collodion has also been recommended as a vehicle for the blue sensitising solution, and the results are perhaps more permanent. The formula is: pyroxyline (high temperature) 120 grs., methylated alcohol (·820) 6 oz., and methylated ether 5 oz. Mix a day or two before using, allow to settle, coat the article with the mixture, and when set sensitise with the "blue-print" mixture. Substratums of collodion have been known to peel off, and to prevent this the places where the edge of the collodion is to come should be treated before coating with a solution of indiarubber in benzole.

Ordinary glass negatives can only be employed for printing when the surface is flat; on curved surfaces film negatives may be kept in contact by means of elastic bands, as shown in the illustration, or by means of gummed paper at the corners. As it is not desirable to remove the negative from the vase for the purpose of examining the progress of printing, there must be something left to chance, or an actinometer must be used. It is advisable to varnish such pictures when dry. Blue pictures may be toned to a different colour by any of the methods advocated under the heading "Blue-print Process," sub-heading "Toning Blue-prints."

CHINA, PHOTOGRAPHY OF

The principal difficulties in photographing china arise from the highly glazed surface and the consequent reflections. These may be minimised, if not altogether destroyed, by attention to two points. The lighting should never be from the front, but well towards one side—almost a side lighting. An inspection of the pieces being photographed from the position of the lens will show when the lighting produces no direct reflections. In addition, a plain, dark-coloured cloth should be hung immediately behind the camera, so that no light or bright objects may produce reflections. A colour-sensitive plate and a yellow screen should also be employed. In addition to giving a better and a truer rendering of the ornamentation, this also assists in reducing the effects of reflections.

CHINA SILK

A soft material, recommended for cleaning lenses, prisms, screens, and other optically-worked glass surfaces. In using china silk for cleaning ruled screens, merely breathe on the surface before rubbing.

CHINESE WHITE

This white water-colour pigment, which consists of zinc oxide, though formerly much used for retouching photographs for reproduction, has been largely superseded by Albanine, Blanc d'Argent, and Ullmanine. The objection to Chinese white is that it photographs darker than paper; it may, however, be used for mixing with other pigments to form a body colour. R. W. Wood has shown that Chinese white photographs black in ultra-violet light.

CHINOLINE BLUE (*See* "Cyanine.")

CHINOLINE RED (Fr., *Quinoléine rouge*; Ger., *Isochinolinerot*)

Synonym, isochinoline red. A complex, organic dye, obtained by heating benzole trichloride with chinaldine and isochinoline. It is extremely sensitive to light, and this induced Vogel to test it as a sensitiser (*see* "Azaline"). It has now been almost entirely replaced by the isocyanines, but Dr. Miethe has stated that a small addition to an isocyanine bath keeps the plates free from fog; and the following is a typical formula:—

Isocyanine dye sol. (1:1,000 water + alcohol) . . .	10 parts
Chinoline red (1:1,000 w. + alc.)	50 ,,
Water to	500 ,,

The chinoline red also helps to fill up the usual gap in the green.

CHLORAL HYDRATE (Fr., *Chloral hydrate*; Ger., *Chloral hydrat*)

Synonym, trichloraldehyde. $CCl_3CH(OH)_2$. Molecular weight, 165·5. Solubilities, very soluble in water, alcohol, and ether. It is poisonous, the antidotes being ether, cocaine, and camphor. It occurs as transparent, colourless crystals or flat crystalline masses, obtained by the action of chlorine on aldehyde, with peculiar pungent odour and taste. It has been recommended as

a solvent of gelatine for making a mountant, and has been suggested for making a non-inflammable film.

CHLORATES (Fr., *Chlorates;* Ger., *Chlorsaures*)

Salts formed by the action of chloric acid, $HClO_3$, such as potassium chlorate, $KClO_3$.

CHLORHYDRIC ACID (*See* "Hydrochloric Acid.")

CHLORIDE OF LIME TONING BATH

A toning bath, suitable for albumenised paper. Fifteen grains of chloride of gold should be dissolved in 1 oz. of water, a few grains of prepared chalk added, the solution well shaken, allowed to settle, and then filtered, the clear solution being used for making up the bath. The formula is:—

Sodium acetate . .	30 grs.	2·3 g.
Chloride of lime . .	1½ ,,	·11 ,,
Gold chloride (1 oz. of solution as described) .	15 mins.	1·2 ccs.
Water	30 oz.	1,000 ,,

This forms a stock solution which improves by keeping. For use, take 2 oz. and add 8 oz. or 10 oz. of water, this being sufficient for eight whole-plate prints.

CHLORIDE PLATES AND PAPERS

Plates or paper coated with a slow gelatino-chloride emulsion intended for development. (*See* "Emulsion.")

CHLORIDES (Fr., *Chlorures;* Ger., *Chloride*)

A salt formed by the action of hydrochloric acid, HCl, on metal, such as sodium chloride, Na Cl. (*See* respective names of metals.)

CHLORINATED LIME OR CHLORINATE OF LIME (*See* "Lime.")

CHLORINE (Fr., *Chlore;* Ger., *Chlor*)

Cl. Atomic weight, 35·5. A yellowish green, gaseous element, obtained commercially by heating manganese dioxide with hydrochloric acid. A solution of chlorine has been employed as a "hypo" eliminator.

CHLOROBROMIDE EMULSION

An emulsion containing both chloride and bromide of silver, the former being in excess. (*See* "Emulsion.")

CHLOROCYANINE

Eder stated that ordinary (iodo-) cyanine acted better as a sensitiser and that it gave plates freer from fog if it was treated with hydrochloric acid; but König has pointed out that this process only purifies the cyanine, and does not form chlorocyanine.

CHLOROFORM (Fr. *Chloroforme;* Ger., *Chloroform*)

Synonyms, trichloromethane, (improperly) formyl trichloride. $CHCl_3$. Molecular weight, 119·5. Solubilities, 1 in 200 water, miscible with alcohol, ether, and benzole. It is poisonous, the antidotes being emetics, the use of the stomach pump, fresh air, cold douche, strychnine hypodermically. It must be kept in the dark. It is a heavy, colourless liquid, with characteristic sweet smell and taste, and is obtained by the action of bleaching powder on alcohol or acetone. As a solvent of amber, etc., and indiarubber, it is useful for varnishes.

CHLORO-IODO-BROMIDE EMULSION

An emulsion containing chloride, bromide, and iodide of silver.

CHLOROPHYLL (Fr., *Chlorophylle;* Ger., *Chlorophyll*)

Solubilities, slightly soluble in water, soluble in alcohol and ether. The green colouring matter from plants, which was used as a red sensitiser for gelatine plates.

CHLOROPLATINITE OF POTASSIUM (*See* "Potassium Chloroplatinite.")

CHLOROPLATINOUS ACID (*See* "Platinum Perchloride.")

CHONDRIN (Fr., *Chondrine;* Ger., *Chondrin*)

One of the constituents of gelatine (*which see*).

CHOREUTOSCOPE

A fitting for the optical lantern, designed by Beale, of Greenwich, to illustrate persistence of vision. It consisted of a circular glass plate with images drawn upon it, which rotated in the lantern, zoëtrope fashion. In a later and more simple form the images were drawn on a strip of glass, which was used in a special carrier.

CHRIPOTYPE

One of the many printing processes invented by Sir John Herschel, who named it "Chrysotype" (*which see*).

CHROMATED GELATINE (*See* "Bichromated Gelatine.")

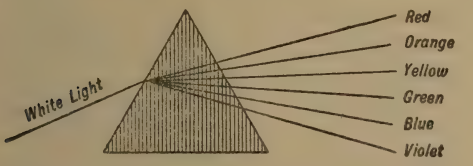
CHROMATES (Fr., *Chromates;* Ger., *Chromsauresalz*)

Salts formed by the action of chromic acid, H_2CrO_4, on a metal, and having the formula $M''CrO_4$. These salts are most of them highly coloured and sensitive to light in the presence of organic matter.

CHROMATIC ABERRATION (Fr., *Aberration chromatique;* Ger., *Chromatische Abweichung*)

To arrive at a proper understanding of the cause of chromatic aberration, it is necessary to remember that a lens is practically a prism with the power of refracting or altering the direction of rays of light and, in an uncorrected form, of refracting rays of different colours to a different extent. Diagram A indicates the effect of passing a ray of white light through a prism; the bending of the rays will be noticed. The most active in their chemical action are the blue and violet, and these are diverted from their original path more than on the others; B shows two prisms placed base to base so that in the case of each colour the rays are directed to a common point. The effect of this arrangement more nearly approximates to that of a simple

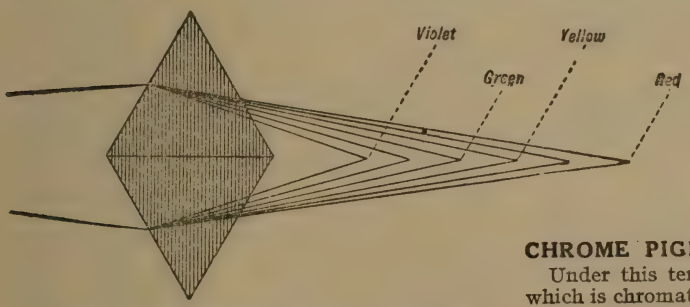
lens as in C, where only three colours are included for the sake of simplicity. Such a lens is in fact a circular prism with the power of bending the rays of one colour so that after passing through it they meet at one point. This point is called the focus, and it will be seen that the focus for the blue-violet rays to which ordinary photographic plates are most sensitive is much nearer to the lens than the luminous rays, green-yellow, which are those that form the visual image upon the focusing screen. This is chromatic aberration in its simplest form. If the image produced by such a lens upon the



A. Ray of White Light Passed through Prism

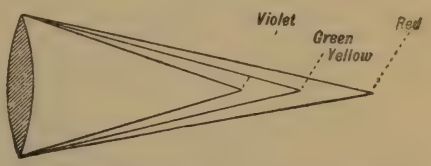
ground-glass screen be examined with a magnifier, it will be found that the outline of any bright object, such as that of a white china knob, is surrounded with a fringe of colour, either blue or orange. If a photographic plate be substituted for the focusing screen there will be obtained a blurred outline, the image being "out of focus." On moving the plate nearer the lens by one-thirtieth to one-fortieth of the total distance between the lens and the visual focus, there will be obtained on a plate an image which is practically sharp. When using ordinary spectacle lenses, a course that is possible where extreme definition is not required, the precaution above mentioned must be observed.

The avoidance of chromatic aberration in a photographic lens is effected by the use of at



B. Rays Passing through Prisms Placed Base to Base

least two kinds of glass possessing different degrees of refraction (or bending power) and dispersion (or power of spreading out the various colours). These glasses, in the case of ordinary landscape and portrait lenses, were usually (1) crown glass, which, if made to suitable curves, could be caused to give any desired degree of refraction with the minimum of dispersion; and (2) flint glass, which had a higher degree of refraction, but relatively a much greater dispersion. The simplest form of single achromatic lens is composed of a double convex crown element and a double concave flint one (*see* D). In ordinary photographic lenses the optician combines the most visually powerful region of the spectrum, namely the green and yellow near the D line, and the most chemically active, namely the blue and violet near G. It will be seen that the red rays are neglected, but in ordinary photography this is of little moment. In three-colour work, in which one of the images is made through a red screen, a higher degree of correction is necessary, and by the use of a third variety of glass it is possible to bring the red rays to a focus in the same plane as the green and blue,



C. Rays Passing through Lens or Circular Prism

so that images taken through screens of these colours are identical in sharpness and size. A lens of this description is called apochromatic (*which see*). Recent advances in glass manufacture have rendered the old terms "crown" and "flint" somewhat meaningless, as the dispersive elements are now frequently made of special forms of crown glass.

CHROMATISM

A lens that possesses the defect of chromatic aberration, described in the previous article, is said to suffer from chromatism.

CHROMATYPE (*See* "Chromotype.")

CHROME ALUM (*See* "Alum.")

D. Simplest Form of Single Achromatic Lens

CHROME PIGMENTS

Under this term are classified lemon chrome, which is chromate and sulphate of lead; chrome green, a mixture of chrome yellow and prussian blue; chrome yellow, a normal lead chromate; and chrome orange and chrome red, which are basic lead chromates. They are occasionally used in colouring prints, but possess little photographic interest.

CHROMIC ACID (*See* "Chromic Anhydride.")

CHROMIC ANHYDRIDE (Fr., *Acide chromique*; Ger., *Chromsaure Anhydrid*)

Synonyms, chromic acid, chromium trioxide. CrO_3. Molecular weight, 100. Solubilities, 1 in 0·6 water, decomposed by alcohol. It is poisonous, the antidote being emetics, then

milk, white of egg, and calcium saccharate. It must be kept dry. It violently explodes when it comes in contact with organic substances. It is in the form of deep, reddish brown acicular crystals, and is obtained by the action of sulphuric acid on potassium dichromate. It has been suggested for bleaching prints, but the potassium salt is more generally used.

In process work, chromic acid is used as an addition to the fish-glue enamel solution. It increases sensitiveness and hardens the film, making it hold better on the metal. The acid should be pure, in fine, needle-like, purple crystals, not the red efflorescent variety used for electric batteries. Chromic acid is also used with sulphuric acid for "clearing" the fish-glue image before etching, by which means it removes any scum from between the half-tone dots.

CHROMIUM INTENSIFIER

For this intensifier two stock solutions should be prepared; each will keep indefinitely.

A.	Potassium bichromate.	½ oz.	55 g.
	Water . . .	10 ,,	1,000 ccs.
B.	Hydrochloric acid .	½ oz.	55 g.
	Water to . . .	10 ,,	1,000 ccs.

The working solution is prepared by taking 1 part A, 1 part B, and 2 parts water. The mixed solution will not keep. The plate, after being well soaked in water, is immersed in this solution until thoroughly bleached, and is next well washed until the yellow colour of the bichromate quite disappears, exposed to daylight for a few minutes, and then redeveloped. Any alkaline developer may be employed, but pyro is not so suitable as those that are used for making bromide prints. Both amidol and metol-hydroquinone are good. A moderate degree of intensification is secured, the printing value being multiplied by 1½; but if this should be insufficient, the operation may be repeated, and increased intensity will be obtained each time. The result is quite permanent.

CHROMIUM POTASSIUM SULPHATE

Commonly called chrome alum (*which see*, under the heading "Alum").

CHROMO-COLLOTYPE

A process of collotype printing in colours. The term is also applied to a method of combining collotype with chromo-lithography for colour printing.

CHROMO-CRYSTAL

A type of coloured photograph similar to crystoleum and popular in the early days of albumen prints. The print was pasted face downwards on a piece of thick plate glass, coloured at the back, and backed up with another piece of thick glass, the coloured picture having the appearance of being embedded in crystal. The method is now employed, with or without the back glass, for producing ornamental paperweights and other fancy articles.

CHROMOGRAM

The name given by Ives to the three constituent pictures for his Kromskop.

CHROMO-PHOTOGRAPHS

An early name given to photographs coloured from the back, now known as crystoleums (*which see*).

CHROMOSCOPE

The earlier name of the Ives Kromskop (*which see*).

CHROMOTYPE

A process of reproduction in colours by means of half-tone blocks, either by three-colour or four-colour printings.

CHRONOMETRIC SHUTTER (Fr., *Obturateur chronométrique*; Ger., *Chronometrischer Verschluss*)

A shutter mechanically geared to give a precisely timed exposure, or successive exposures at accurately recurring intervals.

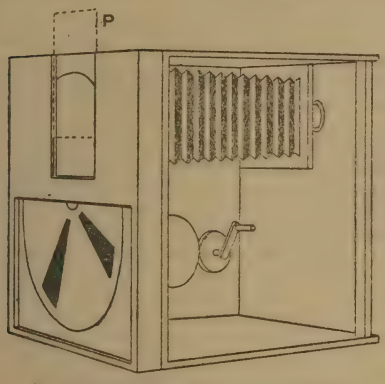
CHRONO-PHOTOGRAPHY

The art of making photographic records of the motion of an object in chronological order.

In the year 1870, Prof. E. J. Marey, of France, commenced his researches on the analysis of motion, and the advance in sensibility of photo-surfaces has lent continual aid from that time onward. The object of chrono-photography is to discover the successive attitudes which collectively make up a given motion, and to embrace phases of a swiftly-moving object otherwise escaping the notice of the unaided human eye. From a physiological point of view, this branch of the photographic art has proved of inestimable value, and it has served to dispel from the minds of artists certain erroneous ideas hitherto held regarding the various poses assumed by animals, birds, and the like, during the evolution of their movements.

In the year 1865, Messrs. Onimus and Martin exposed the bared heart of a living animal before an open lens for the purpose of photographing it while in motion. With the low degree of sensibility then obtaining among photo-surfaces, the exposure necessarily extended over one or more pulsations of the heart, but as a pause takes place at each extreme of the heart's beat the outline of these positions was better defined than the space between, and a record was therefore obtained of the maximum and minimum limits of a pulsation. Clearly it is only necessary to secure outlines of several intermediate positions in order that the experiment should attain this character of chrono-photography, properly so-called. A photograph of a man lifting his arm would (if the exposure lasted during the whole movement) result in a blur, but if a number of separate exposures was made in the same time a series of overlapping images, equal in number to the exposures, would occupy the place of one-exposure blur, and the outlines of these images would in addition form a perfect record of the successive positions of the arm. An ocular demonstration of these phenomena may be readily produced by means of any ordinary photographic camera, supplemented with a disc perforated with a number of holes, and so attached to the lens that by rotating the disc each of the apertures comes opposite the lens in succession. By pointing the apparatus to cover a man walking

along the footpath, and observing the inverted image on the ground-glass screen of the camera, meanwhile rotating the aperture disc, successive and clearly defined images of the man will be seen. Marey's chrono-photographs were obtained somewhat in this way, and diagram A shows his



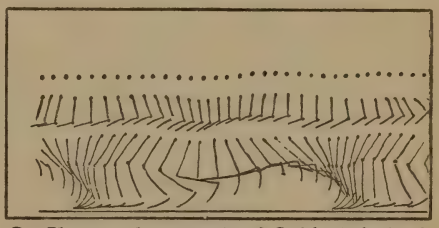
A. Marey's Device for Obtaining Chrono-photographs

of a seagull. One of them is remarkable for showing the wings in a downward position. It is a curious fact that European artists seldom or never represent this downward stroke of the wing, but that the Japanese frequently do. Two years after Marey started his researches in

D and E. Pictures Obtained with Marey's Photographic Gun

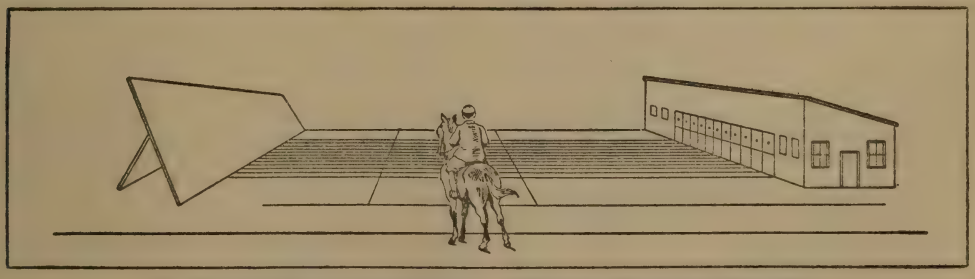
B. Subject in Special Suit for Chrono-photography

precise apparatus. A sensitive plate was placed in a slide at P. A disc with apertures revolved between the lens and the plate. On turning the handle at the side, which communicated the necessary motion to the disc, a rapid succession of images was secured. Marey found that the images, which were almost superposed, made it difficult to distinguish individual phases. To overcome this defect the subject, as shown at B, was attired in a black velvet suit, with dots and white lines marked thereon. During the act of photographing, the subject ran, jumped, or walked against a black background, in a direction at right angles to the axis of the lens. The result was a (negative) image, as represented at C, in which each separate attitude of the head, left arm, and leg can be easily distinguished. Such pictures provide valuable data in physiological research. In order to secure complete and detached pictures of birds in flight, Marey contrived a photographic gun (*see* "Gun and Revolver Cameras"), which was of real value for analysing motion in such a way that the record could be subsequently re-compounded by means of the zoëtrope (*which see*). D and E are enlargements from two of a series of pictures obtained with this gun, representing the flight of a seagull. One of them is remarkable for showing the wings in a downward position. It is a curious fact that European artists seldom or never represent this downward stroke of the wing, but that the Japanese frequently do. Two years after Marey started his researches in France, Muybridge, of California, began to investigate the progressive movements of animals, his operations being carried out in the open air,



C. Chrono-photograph of Subject Attired as at B

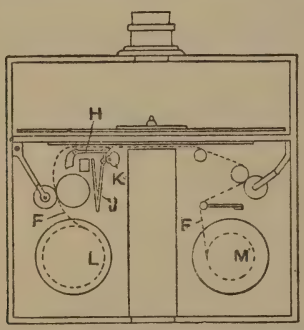
as shown at F. In 1877 he erected a long shed containing a battery of cameras, and stretched in front of it, at right angles, a series of threads, which became broken as the subject (a man on horseback) proceeded along the course. The breaking of each thread communicated electrically with the corresponding camera in the shed, and effected the necessary exposure just at that moment when the horseman was opposite the lens. A slanting fence-reflector formed



F. Muybridge's Arrangement for Obtaining Chrono-photographs

a suitable background for the subject, which was silhouetted against it, and the ground was covered with indiarubber to prevent dusty clouds flying from the horse's hoofs. Muybridge's chrono-photographs of animals in motion, especially of the horse, gave rise to much controversy. The first thought on looking at some of the attitudes portrayed is that they are unnatural and impossible; but the matter is explained when it is remembered that the eye has a certain peculiarity not shared by optical instruments, namely, persistence of vision. An impression of everything looked at remains upon the retina for about one-eighth part of a second; and it is obvious that movements occurring in less time than the period named cannot be appreciated by the eye. In looking at a galloping horse the general effect of the movements is observed, and they are involuntarily commuted into three or four positions. Such positions have been adopted by artists from time immemorial, and we have thus come to regard them as being correct.

The Muybridge system of chrono-photography



G. Marey's Final Chrono-photographic Device

was modified by Anschütz, of Lissa, in Prussia, who added many new features to the apparatus and secured results superior to those of the earlier investigator. Prof. Marey, already alluded to, later devised a camera in which a roll of sensitised paper could be used, and finally substituted transparent celluloid film. His final apparatus is shown at G. A clamp H is supported by a spring frame J. A cam K effects the feed motion of the film F, which is wound upon rollers or spools I, and M. By means of this instrument Marey was able to secure a much longer series of pictures than was possible with his earlier machines. (*See also* under the heading "Kinematography.")

CHRYSOIDINE, OR DIAMIDO-AZOBENZENE (Fr., *Chrysoïdine;* Ger., *Chrysoidin*)

An orange aniline dye used as a light filter in orthochromatic and three-colour photography. Its formula is $C_6H_5N_2\,C_6H_3(NH_2)_2$. The hydrochloride of the base crystallises in brown octahedrons. According to Frederick Ives, it is possible to employ a chrysoidine filter for orthochromatic work without colour-sensitising the plates, but extremely long exposures are then necessary.

CHRYSOSULPHITE (Fr., *Chrysosulfite;* Ger., *Chrysosulfit*)

A preparation of magnesium picrate introduced by Lumière as an addition to developers, so that plates could be used in daylight. Chrysosulphite No. 1 contains 100 parts of anhydrous sodium sulphite and 50 parts of magnesium picrate. No. 2 contains 100 parts anhydrous sodium sulphite and 15 parts magnesium picrate. This preparation has found but little general use. The normal strength in developers varies from 8 to 12 per cent.

CHRYSOTYPE

An obsolete process analogous to the blue-print process, invented by Sir John Herschel in 1842; known also as "chripotype." It can be best described in the inventor's own words:

"Paper is washed with a moderately strong solution of ammonia-citrate of iron, and dried. The strength of the solution should be such as to dry into a good yellow colour and not at all brown. In this state it is ready to receive a photographic image, which may be impressed on it either from nature in the camera or from an engraving (or positive) in a printing frame in sunlight. The image so impressed, however, is very faint and sometimes hardly perceptible. The moment it is removed from the frame or the camera, it must be washed over with a neutral solution of gold of such strength as to have about the colour of sherry wine. Instantly the picture appears, not, indeed, at once of its full intensity, but darkening with great rapidity up to a certain point, depending upon exposure and strength of solutions. At this point nothing can surpass the sharpness and perfection of detail of the resulting picture. To arrest this process and to fix the picture (so far at least as the further agency of light is concerned) it is to be thrown into water very slightly acidified with sulphuric acid, and well soaked, dried, washed with hydrobromate of potash, rinsed, and dried again."

Herschel later recommended developing with a solution of nitrate of silver instead of gold, and fixing in sodium hyposulphite; and other workers advocated the use of a solution of potassium iodide after developing with gold. The finished chrysotype pictures were of a purplish colour.

CHRYSTOLOTYPE

An early and secret process of making paper negatives, invented by a Mr. Whipple. He afterwards published an albumen process in which glass was used, giving similar, if not identical results, this leading to the supposition that the negatives were on a kind of albumen paper.

CINEMATOGRAPH (*See* "Kinematograph.")

CIRCLE OF ABERRATION

The spreading of the image of a point of light into a disc of appreciable size. This may be due to spherical aberration or to diffraction.

CIRCLE OF ILLUMINATION

A term used to express the diameter of the largest circular picture produced by a lens working

at its "infinity focus," irrespective of definition or equality of illumination. A lens having a relatively large circle of illumination as compared with its focal length is known as a wide-angle lens. The extreme range in lenses commercially obtainable is from a circle having a diameter five times the focal length of the lens, as in the Goerz "Hypergon," to a circle barely equal to the focal length, as in the Petzval portrait lens.

CIRCLE OF LEAST CONFUSION

The theoretically perfect lens is capable of sharply reproducing a point or a line, no matter how small or fine. In telescope and microscope objectives, where only rays near the axis of the lens are used, this condition is nearly fulfilled, but in photographic lenses, where approximate sharpness over an extended field is desired, this critical definition at the centre of the field is sacrificed in order to obtain other qualities. The size of the disc to which the image of a theoretical point is spread out by any lens is called the circle of least confusion, and is a measure of the defining or "resolving" power of the lens; in British practice, $\frac{1}{100}$ of an inch is the maximum diameter of such a disc of which a "sharp" picture can be composed, but latterly on the European Continent $\frac{1}{200}$ of an inch is often taken as the standard of sharpness. To realise what this means assume that an engraving is composed of lines and dots $\frac{1}{600}$ of an inch in width; with a lens having a disc of confusion of $\frac{1}{100}$ of an inch a full sized copy would have the lines and dots broadened out to more than $\frac{1}{100}$ in., but at 10 in. distance from the eyes the whole picture would appear to be sufficiently sharp. By stopping down the lens the sharpness can be increased until almost any desired degree is attained. The circles of confusion at the true focus are due to spherical aberration (*which see*), but they are also found in portions of the image which are "out of focus" and are easily recognised in the backgrounds of portraits. In this case they are due to the plate cutting the cone of rays at some distance from the point of sharp focus.

CITOCHROME (Ger., *Citochromie*)

A process of four-colour printing from half-tone blocks, invented by Dr. Albert, of Munich. The black or grey plate is printed first, and then the yellow, red, and blue, but the solid parts of these colours, which would in the ordinary process print over each other and imperfectly produce black, are cut out during the process of making the plates, so that the black first printed shows through the three-colour impressions and prints as pure black. The inventor claims that by this means more rapid colour printing can be done, as there is no waiting for the solid colours to dry before each successive colour is superimposed. In carrying out the process continuous tone negatives of the colour separations are made, and also an orthochromatic negative of the black. A positive is prepared from the latter. The continuous tone negatives for the colour separations are put in a special printing frame, together with the positive of the black plate and a ruled screen, the whole being in contact with a sensitised zinc plate. Either the frame or the arc light is made to describe a circular path in a vertical plane so as to spread the light passing through the ruled screen. The positive of the black plate has the effect of stopping out the dark parts of each negative. The negative of the black plate is, of course, made without the positive plate being superposed.

CITRATES IN DEVELOPMENT

Alkaline citrates have been recommended as restrainers in dry-plate development in place of potassium bromide. The consensus of opinion is that bromide is better than any citrate if added to the developer before it is applied to the plate, but that citrates (particularly ammonium citrate) act better as restrainers when once development has begun. If added in sufficient quantities, citrates correct over-development better than bromide, and have the advantage that, after they have been added to the developer, density can be obtained without further fogging, though the development of detail has stopped. If ammonium citrate itself is used—or, in fact, the citrates of either potash or soda—the usual quantity required to be effective is from 6 to 12 grs. per ounce of developer; but obviously more or less can be used. The ammonium citrate is the most widely used and appears to work well with all developers, but when potash or soda is used as the alkali in a developer the citrates of potash and soda are to be preferred.

CITRIC ACID (Fr., *Acide citrique;* Ger., *Citronensäure*)

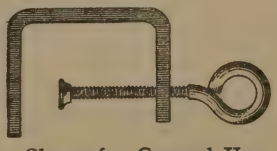
Occurs in colourless and odourless crystals, or amorphous powder, and has a strong acid lemon-like flavour. $C_6H_8O_7H_2O$. Molecular weight, 210. Easily soluble in water, either cold or hot, slightly soluble in ether, and still less so in alcohol. It is hygroscopic, and should be kept in a well-corked bottle. Aqueous solutions of citric acid, and all other alkaline citrates, develop in course of time a fungoid growth, due to *Saccharomyces mycoderma*, with decomposition into carbonic acid and water. Citric acid is used in some developers as a preservative and in others as a restrainer, for making acid fixing and clearing baths, and as a preservative in emulsions.

CITRO-CHLORIDE PAPERS

Another name for gelatino-chloride printing-out papers (*which see*).

CLAMP (Fr., *Crampon, Agrafe;* Ger., *Klampe*)

There are several kinds of clamps used in photography. The lantern-slide clamp is intended for holding the slide and cover glass firmly



Clamp for General Use

together while binding. The etcher's clamp is used when etching copper plates face downwards in the ferric perchloride bath; it is made of oak thickly varnished. Various kinds of clamps are

employed in chemical operations, for supporting burettes, test-tubes, retorts, etc. Fretwork clamps (*see* illustration) are cheap and are often useful to secure photographic apparatus in unusual situations, to support backgrounds, or to improvise temporary accessories. Clips (*which see*) are occasionally wrongly referred to as clamps.

CLARIFYING

A term applied usually to the mechanical clearing of a solution by allowing a precipitate to settle or by causing more rapid precipitation by the addition of some inert substance to carry down a precipitate which does not easily subside. It is occasionally used to obtain clear solutions of varnishes, when an inert powder like pumice or chalk is added.

In process work, the fish-glue that is used must undergo a process of clarifying, and "clarified fish-glue" is obtainable as a commercial product. Formerly, process workers had to clarify the glue themselves, and some still prefer to do so. It is done by adding an equal quantity of albumen and heating the glue to boiling-point, stirring well the whole time, and boiling for one minute. The albumen coagulates and holds the suspended matter, which can then be filtered out.

CLAUDE LORRAINE GLASS

A convex mirror of black glass, commonly known as a "Lorraine mirror," or "Claude glass." It was used by Claude Lorraine, the famous French painter, nearly three centuries ago as a means of reducing the view and at the same time modifying the colours. Used in photography, it is of service in showing how a view will look when reduced and, to a certain extent, when reproduced in monochrome. Used in cloud photography, it facilitates the obtaining of the necessary contrast between the clouds and the blue sky, owing to the fact that the black glass does not reflect the whole of the ultra-violet light. A convex glass, silvered but not blackened, is used on the reading desk by lecturers to reflect the lantern pictures shown on the screen, and to reproduce them in miniature for personal reference while speaking.

CLAUDET, ANTOINE JEAN FRANCOIS

Born in France, 1796; died in London, 1867. One of the earliest workers and improvers of the Daguerreotype process in England, and one of the last to use it professionally. In 1840 there were only two photographic establishments in London, those of Beard and Claudet. Claudet was also a partner in the firm of Claudet and Houghton (1834). In addition to improving the Daguerreotype process by the employment of chlorine vapour to increase the sensitiveness, he, in 1844, took out a patent for the use of red light in the dark-room. One month before his death his studio in Regent Street was burned down, and all his valuable daguerreotypes, pictures, and papers destroyed.

CLAYBOARD

A cardboard thickly coated with a chalky enamel and used by artists for drawing upon. The chalk surface permits of high lights to be scraped out and white lines to be cut through the blocks. This board may be sensitised with silver nitrate for printing under a negative so as to form a basis for drawing on. The surface is first prepared with arrowroot and ammonium chloride in the usual way adopted for sensitising plain papers.

CLEANING BOTTLES

The methods employed for cleaning bottles will depend upon what the bottles have contained. The simple and old-fashioned method of half-filling the bottle with water and adding sand, cinders, or shot may serve in some cases, as may the use of a little vinegar and broken-up egg-shell. Generally, however, the best bottle-cleaning solution is one made in the proportion of from 2 oz. to 4 oz. of hydrochloric acid to one pint of water. This mixture is allowed to remain for a time in the bottle, shaken frequently, poured into another one, and the bottle rinsed well with clean water. Bottles that have contained oil should be rinsed first with a strong solution of household washing soda, caustic soda or potash, or liquor ammoniæ, and finally with weak hydrochloric acid. Commercial benzole may also be used for greasy bottles, followed by a strong solution of washing soda, finally rinsing with plenty of water.

Bottles which have been used for varnish may be cleaned by rinsing with liquor ammoniæ 1 part, methylated spirit 10 parts, and finally with weak ammonia and water. It is better to use liquid than mechanical cleaners (sand, shot, etc.), which are apt to roughen the insides of the bottles, such roughness causing them to become dirty and unsightly very quickly. Bottles used for gold toning solutions quickly become dirty owing to the gold depositing itself upon the inside of the bottle; if the deposit is not removed the gold in fresh solutions will be attracted by it, to the detriment of the solutions. Weak hydrochloric acid should be used as a cleaner for such bottles, and if this fails *aqua regia* should be used.

CLEANING DAGUERREOTYPES

(*See* "Daguerreotypes, Cleaning and Restoring.")

CLEANING DISHES

Dishes used for "hypo" should not be put to other photographic purposes, even after cleaning, as any print treated therein is liable to be stained. Dishes used for developing and toning soon become dirty, particularly when the developer oxidises quickly, as pyro, for example. All dishes require to be cleaned at intervals, but those made of porcelain appear to require the most cleaning. There are two kinds of stains, those which appear on the surface of the glaze, and those which find their way under the glaze into the very substance of the dish, from which it is almost impossible to remove them. A solution of hydrochloric acid will remove most surface stains without damaging the dish, the method being to pour water into the dish and add hydrochloric acid until the solution is strong enough; commercial spirit of salt will do equally well and is cheaper. An old tooth-brush, or a rag tied to a stick, may be used for the corners, it not being advisable to use the fingers. Fresh

stains will not require to be rubbed. For obstinate stains, mix together 8 oz. of pearl-ash, 4 oz. of quicklime, and 1 pint of water, stir up and place in the stained dishes; allow to remain for one hour, pour out, rinse with very dilute hydrochloric acid in order to destroy the last traces of the pearl-ash and lime, and finally wash well. However, spirit of salt is more generally used, and it makes dishes chemically clean enough, even if it does not entirely eliminate the stains.

To remove slight stains from fragile dishes, rub damp salt on them with a piece of flannel, or rinse with very dilute hydrochloric acid and then rub with salt.

CLEANING LENSES

It is easy to damage a lens by improper cleaning, optical glass being generally much softer than other kinds. Apart from actual scratches the surface is liable to become dulled, a condition that affects the "rapidity." The necessity for frequent cleaning is obviated by fitting all lenses with caps to both front and back combinations, or by keeping them in air-tight cases. When a lens requires cleaning it should first be dusted with a camel-hair brush or tuft of cotton-wool, and then carefully wiped with a very soft silk or linen handkerchief, or with a soft wash-leather. If the surface still appears cloudy, a single drop of pure alcohol should be put on each of the surfaces, which should be carefully wiped until quite dry. The spirit must not be allowed to run between the lens and its brass cell, and care must be taken not to remove the dead black coating from the lens cell. The edges of the lens in contact with the cell are best cleaned with the pointed end of a bit of soft wood over which the rag is stretched. Dr. Miethe recommends the use of pith, such as that of the rush or elder, for this purpose. A lens that has become scratched or dulled should be sent to the maker to be repolished. The greatest mistake an amateur can make is to attempt to repolish a lens with rouge, putty-powder, etc.; even the maker cannot repolish a badly scratched lens so that it will work quite as well as when it was new, therefore the result of unskilled work can easily be anticipated. A lens should not be wetted if it can be avoided, and in the case of condensation of steam or dew upon the surfaces, the moisture should be removed as quickly as possible.

CLEANING NEGATIVES

The films of negatives are best cleaned when wet. Usually they are merely wiped over with a piece of wet cotton-wool; but to remove a dirty or messy appearance from a dry negative use cotton-wool soaked in methylated spirit, rubbing very lightly to avoid reducing the density. The metal-polish reducer (*see* "Baskett's Reducer") may also be used for cleaning the dried film, but must be used very gently.

It is generally the glass side, not the film side, of a negative that requires cleaning. In the process of manufacture some stray emulsion may get on the glass side, which, if allowed to remain, would show in the print. Emulsion streaks are best removed when wet by rubbing with damp table salt; but the same method answers when the negatives are dry.

To clean off the films from "waster" negatives that have been varnished, soak them in a hot solution of soda or potash, and then rub with a stiff scrubbing-brush, finally rinsing; if potash is used, do not let it touch the fingers. Soaking in water containing a little nitric acid answers for unvarnished negatives, scrubbing or scraping afterwards if necessary. The following solution is also recommended for removing unvarnished films: Citric acid 1 oz., hydrochloric acid 2½ oz., water 20 oz. Soak in this for an hour or two, scrub, and finally rinse.

An excellent cleaning and polishing mixture for glass consists of the following:—

Rain or soft water . .	1 oz.
Powdered pumice-stone . .	1 ,,
Whiting or prepared chalk .	1½ ,,
Liquor ammoniæ . . .	½ ,,

Apply with a piece of chamois leather or flannel, and polish with a clean rag or soft paper.

CLEARING SOLUTIONS

Used for removing development stains from negatives or prints. When the staining is due to insufficient sodium sulphite in the developer the following formula is recommended:—

Alum . . .	1 oz.	55 g.
Hydrochloric acid .	¼ ,,	12 ccs.
Water . . .	20 ,,	1,000 ,,

The plate should be well rinsed from the developer, immersed in this clearing solution for two or three minutes, and then washed for fifteen minutes and fixed as usual. The use of an acid fixing bath renders a clearing solution unnecessary. For clearing development fog, or chemical fog, or staining caused by the plates or paper being stale, a solution of thiocarbamide is the best to employ. (*See* under the heading of "Fogged Negatives, Treatment of." Lantern slides are treated as described under their own heading.)

In process work, clearing solutions are used to remove any deposit of silver from between the dots of half-tone negatives, and also to sharpen up the dots. This process is called "cutting." For dry plates, ferricyanide and "hypo" (Farmer's reducer, *which see*) is used, and for wet plates, iodine and cyanide.

CLERK-MAXWELL, JAMES

Born at Edinburgh, 1831; died at Cambridge, 1879. First Professor of Experimental Physics at Cambridge (elected 1871). He made researches into the composition and vision of colour, the kinetic theory of gases, electricity, etc., and was associated with the early experiments in colour photography, with regard to which he made, about 1861, many suggestions.

CLICHÉ

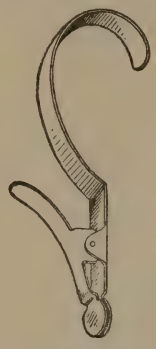
The French term, now anglicised, applied to electrotypes, stereotypes, and process blocks. Also used sometimes to indicate negatives and positives. (*See also* "Block.")

CLIPS (Fr., *Pinces*; Ger., *Klammern*)

Spring clips of various kinds are used for hanging up wet prints or films. The American wood clip A is useful for many purposes; clothes

" pegs " of practically identical shape are obtainable at a very cheap rate. Metal clips B are obtainable in variety. Such clips are especially useful for suspending sensitised carbon tissue or photo-lithographic paper for drying. Split

A. Wooden Clip



B. Metal Clip

corks with rubber bands make good clips for some purposes (*see* an illustration referred to under the heading "Film Manipulation"). Negative clips, or plate-holders, are used for holding and lifting negatives during development, washing, etc., to avoid touching them with the fingers. Film-developing clips are intended for holding the ends of roll-films when developed in the length.

CLIP COPYBOARD

A board used in process work for holding the original for copying; it is provided with spring clips instead of with pins. In one type the clips slide in grooves, whilst in another they are inserted in holes, and large clips to hold books and small clips to hold paper or cardboard are provided.

CLOCK, DARK-ROOM (Fr., *Horloge de laboratoire*; Ger., *Dunkelzimmer Uhr*)

A clock specially made to facilitate the timing of photographic operations. The Watkins dark-room clock, a former pattern of which was known as the eikronometer, is primarily designed for factorial development. It has two hands, one completing a revolution in one minute, while the other takes ten minutes. A stop motion permits both hands to be started from zero as the developer is poured on the plate, and an outside indicator marks the completed time. The Welborne Piper stop clock is for factorial development, and for timing numerous other manipulations, in addition to which it has various novel and useful movements.

CLOTH, BOLTING (*See* "Bolting Cloth.")

CLOTH, FOCUSING (*See* "Focusing Cloth.")

CLOUD NEGATIVES

Clouds that are to be added to landscapes must be taken under similar conditions to those of the landscapes for which they are required. A large common or open space should be selected for photographing, so that a low horizon line may be included on the plate. And this low horizon line should be as unbroken as possible. The formation of clouds near the horizon is different from that at higher altitudes, and it is therefore necessary that clouds near the horizon should be included on the plate so that they may appear correct if the formation of the landscape picture necessitates showing sky near the horizon. Clouds taken right opposite the sun, or directly towards it, are quite useless for adding to the large majority of landscape pictures, as most landscapes are taken with an oblique front lighting. Clouds should therefore be photographed with a similar lighting. If the sun should be in the south at the time of photographing clouds, those about the north-west and north-east will be the most useful. As opportunities offer, cloud negatives should be taken with different lighting, and of varied character; brilliant piled-up masses, rain clouds, broken-up skies, quiet, calm, summer effects, etc., so that a suitable negative can be be selected when it becomes necessary to add clouds to a cloudless landscape. It is necessary to study the arrangement or grouping of the clouds on the plate so as to get the principal point of light, or the principal feature in the grouping, towards one side of the plate. The grouping must be such that it can be utilised in assisting the formation or composition of a picture whenever practicable. The principal cloud masses should form an angular line across the plate. The exposure for cloud negatives must be very short, ranging from one-sixtieth of a second for very light clouds, up to one-fortieth for heavy masses, using a rapid plate (200 H. and D.), and lens aperture *f*/16 at mid-day in late spring or early summer. Development may be normal. With such short exposures the negative will be thin, and suitable in every way for printing into landscapes.

CLOUD SHUTTER (*See* "Foreground Shutter.")

CLOUDS, PRINTING IN

The landscape or marine picture should be printed first and the clouds added subsequently. No attempt should ever be made to block out the sky on the landscape negative, even if it should print to a pale grey tone. Painting out a sky leaves the outlines of the distance hard and crude, instead of delicate and soft, as they invariably appear in a landscape print, even if sharply defined throughout. It is no disadvantage to print a sky over a pale tone of grey; the clouds are softened in their contrasts, and frequently harmonise better with the tone of the landscape. At times, the grey tone of a sky may be a disadvantage when it is desired to add a sky that should be as brilliant as possible for a special effect. In that case the sky may be kept white by shielding. A card is roughly cut to the shape of the outline of the landscape, and supported over the sky part of the picture during printing, the edge of the card being directly over the outline of the landscape. This plan allows the landscape to print fully, but the sky will be vignetted off from its full printing, where it joins the landscape, to a pure white for the greater part of its area. The suddenness or the gradual nature of this vignetting will be determined by

With Ordinary Plate

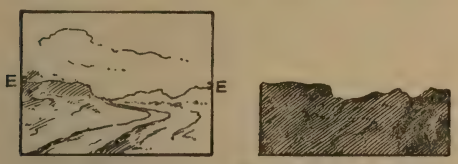
With Isochromatic Plate and Medium ("Three Times") Screen

With Isochromatic Plate, but Without Screen

With Isochromatic Plate and "Six Times" Screen; over-corrected

VARIOUS RENDERINGS OF DAFFODILS IN BLUE VASE

the distance of the card from the surface of the negative. When the landscape print is obtained, a mask is also required, to be used to shield it from the action of the light while the clouds are printed. The most satisfactory method of obtaining this mask is to take a rough silver

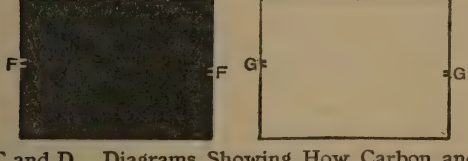


A and B. Landscape Negative and Mask

print of the landscape, and cut it carefully to the outline of the subject. Any small dark objects, such as a church spire, the branches and twigs of a leafless tree, may be disregarded in cutting this mask, as the clouds may be printed over them. But the mask must be cut so as to shield any light object, excepting in special cases which must be determined on their merits. The landscape and mask are shown at A and B. The landscape print must be placed in position behind the cloud negative, care being taken that the horizon of one is near the horizon of the other, so as to ensure that the cloud forms are in correct relation to the landscape. The clouds must be printed in a frame one or two sizes larger than the landscape, the frame being provided with a sheet of plain glass so that the smaller negative can be printed without difficulty. The large frame allows space for arranging the landscape print in the correct position on the cloud negative irrespective of the extent to which it may project in any direction.

If a large number of prints are required from one negative, the most satisfactory manner of using the mask is to attach it permanently to a piece of glass the same size as the print. If only a few are wanted, the mask may be wetted sufficiently to render it quite limp; it will cling to the glass thoroughly satisfactorily, without risk of movement, while the sky is printed. In either case, the mask is adjusted in position on the outside of the plain glass in the printing frame when everything is ready for printing the clouds. The frame should be in a horizontal position.

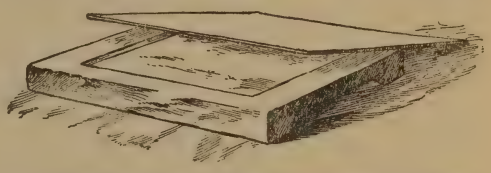
The mask should be carefully adjusted so that it overlaps the landscape very slightly, about one-sixteenth of an inch, or less in small work



C and D. Diagrams Showing How Carbon and Bromide Prints are Marked for Masking

The fact that there are two thicknesses of glass between the mask and the print—the plain glass of the frame and the sky negative—will cause the mask to print with a soft or vignetted outline, and this slight overlapping is to compensate for the manner in which the light diffuses under the mask, and it prevents the print from showing any hard junction. In addition, a card should be supported over the landscape portion, as shown at E, while the clouds are being printed; this card should project over the sky to a small extent to soften off the depth of printing near the horizon. The extent and nature of this softening will be determined by the extent to which the card projects beyond the landscape and its height above the surface of the negative. The edge of the card may be either straight or cut approximately to the outline of the landscape, according to the subject. This vignetting off towards the horizon becomes absolutely necessary when a grey sky has been vignetted into a plain white, as described earlier.

All preliminary work in cloud printing should be on silver printing-out paper. Working by daylight in a process that gives a very strong image enables the work to be followed easily. The mask can be adjusted to the correct position without any difficulty, and any error in adjustment or in arranging the card shield can be seen at almost the beginning of printing, and rectified immediately. The experience gained by printing clouds in silver will enable any photographer to place the masks and shields correctly without difficulty when adding clouds to platinotype



E. Shielding Part of Negative when Printing

carbon, or bromide prints, though in these processes there is no strong image to act as a guide.

The method of working in platinotype and carbon, inasmuch as they are daylight processes, will be similar to that described for silver printing, but there is no image that can be seen sufficiently well through the cloud negative to assist in correctly placing the mask. In platinotype, the image is an assistance, but it cannot be utilised in the same manner as in silver. When the landscape print is taken from the frame, a small pencil mark is made at each end of the print, at the exact point to which the mask has been cut; and about an eighth of an inch above each mark, a second one is made to serve as a guide in placing the mask. These pencil marks are shown at E E. When the landscape is being arranged under the cloud negative, these pencil marks are of great assistance in securing the correct position. But their great value consists in the manner in which they enable the correct placing of the mask to be determined. They are plainly visible through the cloud negative, and the mask can be fitted to them as easily as to the strong image of a silver print. It is self-evident that if the mask is in the correct position at the two margins it must be in the correct position throughout its length. The exposure should be timed by means of an actinometer.

In carbon prints there is no image whatever

to serve as a guide for marginal marks, and their position must be determined differently. A little water-colour is required—white or light yellow—and a fine brush. When the print is in the frame, either before or after the exposure, one-half of the back of the frame is opened, and a fine mark is made on the margin of the negative at the spot corresponding with the mask. That half of the back of the frame is at once closed again so as to press the tissue on to the negative, and the moist colour will set off on to the margin of the print. While this half remains closed, the other half is opened and a similar mark made on the margin of the negative at the correct position for the mask. The precaution should be taken of opening each half separately a second time to ascertain that the colour has been transferred to the face of the tissue; and, before removing the print, a mark should be made on the back to indicate which is the top. The exposed tissue should then be removed from the frame, the marks strengthened, and a second mark made just above each to correspond with the pencil marks in platinotype. With these marks the correct placing of the mask is easy, and this and the printing will be the same as described for platinotype. The appearance of the carbon print is shown at C, the white brush marks F F corresponding to E E in diagram A.

In bromide printing, the method of working is the same as in carbon, but a dark colour must be used for the brush marks, black or dark-brown. Diagram D illustrates a bromide print to be used with the mask B, the brush marks being indicated at G G. In bromide printing, the card shield must be kept moving during the exposure, to prevent a sharp line from appearing.

In enlarging by means of a lantern, pencil marks can be made on the enlargement, the image thrown by the lens forming the guide. The card shield may be held in any convenient position between the lens and the enlarging easel so as to shield the landscape, and it must be kept in motion throughout the exposure of the cloud negative.

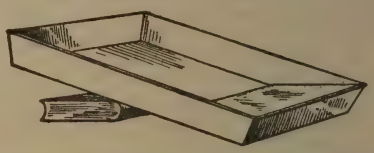
COAL-TAR COLOURS (*See* "Aniline, or Coal-tar, Colours.")

COATING

It will be found somewhat easy with a little practice to coat plates if the operation is practised first in daylight or gaslight, and for this purpose it is advisable to start with whole plates, assuming that one wishes subsequently to obtain quarter plates. A pneumatic holder (*which see*) should be obtained, and the sheets of glass thoroughly cleaned and stacked, with the surfaces to be coated away from the operator. The emulsion should be at a temperature of 95° F. (35° C.) in summer and 98° F. (36·6° C.) in winter; and if the room is cold the glass itself should be warmed. The pneumatic holder is taken in the left hand, the bulb well squeezed, and the lip of the holder just wetted and then pressed on to the back of a sheet of glass in the centre and the pressure relaxed. The suction —really the pressure of the atmosphere on the surface of the glass—holds it firmly against the holder, wherein there is a partial vacuum. The glass should then be held horizontally, and the emulsion poured on to the middle, preferably from an earthenware teapot which has a spout that starts from near the base, as this avoids the air bubbles which rise to the top of the emulsion. Failing a teapot, the ordinary invalid's feeding cup would be a good substitute.

The pool of emulsion should be poured on to the centre of the plate, and, as soon as it covers about half the area, the plate should be tilted so as to cause the emulsion to run to the top right-hand corner, then to the top left-hand corner, then to the bottom left-hand corner, and finally to the bottom right-hand corner, and the excess drained off here. This must be done slowly, otherwise the emulsion will run over the edges; and it is advisable to practise over a good-sized dish so as to catch any spillings. As soon as coated, the plate should be slid on to a sheet of plate glass accurately levelled, and allowed to set.

The coating of paper is not so easy, but it may be done by pouring the emulsion into a dish, tilting this, and drawing the paper over the top of the emulsion. At least a yard of paper can be coated in this way, and with care but few bubbles will arise. But by far the simplest plan is to use one of the film developing dishes provided with a roller. Having the paper cut in long lengths, pass one end round



Tilted Dish of Emulsion for Coating Paper

the roller, and, keeping it tightly strained against the latter, pour in enough emulsion to cover a little less than half the diameter of the roller. Then the paper can be drawn through the emulsion and straight up, and enough will cling to it to give good results. Naturally, the emulsion must be kept hot.

Commercially, of course, special machinery is used both for plates and papers, and in the former case the cleaned glasses are fed on to the bed of the machine and coated with emulsion by various devices. Thence the glasses pass through an ice tunnel, which thoroughly sets the emulsion, and at the other end of the machine, which may be 30 ft to 40 ft. from the coating end, they are stacked in racks by hand and thence conveyed to the drying-room.

The commercial paper-coating machinery is usually arranged so that the paper, which is in long reels, passes round a roller through the emulsion. The coating is chilled either by a cold roller or by cold air; the paper then passes on, is formed into loops or festoons, and traverses the drying-room, being again reeled at the other end.

In process work, coating is an important operation. For collotype, the gelatine coating is applied by levelling the glass plate and pouring on a measured quantity of solution, guiding it to the edges by means of a catgut bow or a

glass rod. For coating zinc or copper a whirler (*which see*) is invariably used, the coating being evenly spread by centrifugal force, while the surplus is thrown off. In the case of very volatile mediums, such as bitumen, it is sometimes the practice to coat by pouring on the solution with a sweep of the bottle along the top edge of the plate, taking care to incline the plate so as to allow the solution to run down and the surplus to run off.

CO-AXIAL

Having a common axis. Thus the positive and negative elements of a telephoto lens or the eyepiece and object glasses of a telescope or microscope are said to be co-axial.

COBALT BLUE (Fr., *Bleu de cobalt;* Ger., *Kobaltblau*)

A compound of alumina and oxide of cobalt used in painting; of slight photographic interest.

COBALT CHLORIDE (Fr., *Chlorure de cobalt;* Ger., *Kobaltchlorid*)

Synonym, cobaltous chloride. $CoCl_2\ 6H_2O$. Molecular weight, 238. Solubilities, soluble in water and alcohol. Ruby red crystals, obtained by dissolving cobalt carbonate in hydrochloric acid and evaporating. The addition of small quantities of cobalt chloride to printing-out emulsions produces greater contrast.

COBALT SALTS, PRINTING WITH

Cobalt belongs to the same group of metals as iron and manganese, and, like these, many of its salts are sensitive to light. Although no practical process has so far been founded on this fact, it is as well to record briefly the researches of A. and L. Lumière on the subject. The most promising salt is obtained by dissolving cobaltic oxide, Co_2O_3, to saturation in oxalic acid solution, or by precipitating cobaltic oxyhydrate from a cobaltous salt solution by means of sodium peroxide and dissolving the precipitate, after careful washing, to saturation in oxalic acid solution, the cobaltic salt being kept all the time in excess. This operation must be performed in the cold, and takes some hours. A green solution is obtained which can be used to sensitise gelatinised paper, and, after drying, on exposure to light under an ordinary negative, a pale rose-coloured image of a cobaltous salt is obtained. The action is extremely rapid, taking but a fraction of the time necessary to print under similar conditions with a silver salt. The print, when ready, should next be immersed in a 5 per cent. solution of potassium ferricyanide and washed. The image thus obtained is a pale rose colour and not very intense, consisting of cobalt ferrocyanide. This may be toned with an alkaline sulphide, which produces dark brown cobalt sulphide. By treatment with an iron salt, a blue image is obtained; a nickel salt gives a red image. Attempts to develop the cobaltous image with organic compounds (*see* "Manganese, Printing with") were not satisfactory, in all cases it being found much more difficult, and the only substances proved to be of any value were hæmatoxyline, which gave a violet blue image that was changed to reddish by hydrochloric acid, and benzidine, toluidine, and their hydrochlorate salts. These produced on the places not affected by light, so that they would give a negative print from a negative, an intense blue image, which was turned brown by ammonia and pale yellow by hydrochloric acid.

Further researches with the citrate, stannate, nitrite, tartrate, gallate, and sulphocyanide of cobalt have been made, but the results were still less promising.

COBALT-LEAD TONING

A process for toning bromide and gaslight prints to a green colour, introduced by MM. Lumière and Seyewetz in 1905. Two solutions are required:—

A.	Potassium ferricyanide .	144 grs.	65 g.
	Lead nitrate .	96 ,,	44 ,,
	Water . .	5 oz.	1,000 ccs.
B.	Cobalt chloride .	½ ,,	110 g.
	Hydrochloric acid	1½ ,,	330 ,,
	Water . .	5 ,,	1,000 ccs.

For vigorous greens fully developed prints must be used. The print is placed in A until bleached, is next washed very thoroughly, and then immersed in bath B. The image on the finished print is made up of lead, silver, iron, and cobalt in the form of a ferrocyanide and of the chlorides of silver and lead. If the toning action is prolonged, the cobalt will completely replace the silver and lead.

COCKLING OF PRINTS

Photographs mounted in a wet state upon thin cardboard, or upon the leaves of an album, invariably cockle or curl when dry, whereas prints mounted surface-dry do not cockle so badly. The defect is due to uneven expansion caused by the wet mountant, and can be made worse by unskilful manipulation. Careful selection of the mountant minimises the trouble, and the following formula is as good as any in this respect:—

White dextrine . .	360 grs.	82 g.
Powdered alum . .	16 ,,	3·6 ,,
Sugar	60 ,,	13·6 ,,
Hot water . . .	1 oz.	100 ccs.

This, when thoroughly mixed, should form a thick cream, which should be allowed to stand a day before use. Take the trimmed dry print and lay it face downwards on a sheet of glass, and with a fairly stiff brush apply the smallest possible quantity of mountant to the back of the print, distributing evenly and quickly; before the mountant has had time to soak through, place the print upon the mount and squeegee or rub down. Place two or three thicknesses of fluffless blotting-paper over the picture and mount, and put into a copying press and screw down hard, or put under heavy pressure for several hours. When dry, there should be little or no cockling.

Another plan is to brush the back of the dry print over with a strong solution of gelatine or soft glue, and to damp slightly the mount before placing the print in position, drying under pressure.

The theory of the subject is to prevent

expansion of the print before pressing it in contact with the mount; or, if this expansion is unavoidable, to expand the mount, as in the preceding paragraph, and let mount and print contract together. Another point is to use a thoroughly even mountant, because should one part of the print get wetter than another, cockling is almost sure to occur.

Photographers may learn something from the draughtsman's method of stretching drawing paper, and even if it is dangerous to mount prints in this way, they can adopt it when pasting brown paper on the backs of photograph frames. The draughtsman slightly damps the back of the paper, thus evenly expanding it all over, touches the margin all round with paste, and "lays" the paper on the board, thoroughly pressing the margin into contact. The paper contracts in drying and becomes as tight as a drum-head.

CODDINGTON LENS

A biconvex spherical lens with a deep groove filled with an opaque substance running round the centre. The groove acts as a diaphragm. This lens is used as a hand magnifier, and gives a large, bright field, but its working distance is short.

CŒRULINE S (Fr. and Ger., *Cæruline S*)

Synonyms, cœruleïn, cœrulean. A compound of alizarine blue and sodium bisulphite, which has been occasionally used for colour-sensitising plates.

COFFEE PROCESS

A mixture of coffee, advocated by Colonel Baratti, used as a preservative in the early days of the dry collodion plate. About 1855 there were numerous announcements of new preservatives wherewith the sensitive surface of collodion plates could be covered, so as to enable them to be dried and kept ready for use. Among the many substances recommended and widely used were beer, tea, treacle, gum arabic, brown sugar, white sugar, raspberry vinegar, wort, malt, and tobacco.

COINS AND MEDALS, PHOTOGRAPHING

The difficulty presented by subjects of this character is solely due to the low relief of the image and the consequent absence of contrast in light and shade. This difficulty may be entirely overcome by suitable lighting. The coin or medal should be placed so that it receives a strong light from one side, the direction of the light being parallel with the face of the coin and striking the edge strongly. There may be a little diffused light in front, but as large a proportion as possible should be across the face, just skimming the surface. However slight the relief, it will be shown by strongly marked lights and shadows if this method of lighting is adopted, and the production of a successful negative will present no difficulty. The exposure must be short.

COINS AS WEIGHTS

English silver coinage is minted exactly by weight in proportion to its value—namely, $436\frac{4}{11}$ grs. for every five shillings; thus a new threepenny-piece weighs 21·8 grs., a sixpence 43·6 grs., and so on, the sixpence and threepenny piece being almost exactly one-tenth and one-twentieth respectively of the avoirdupois ounce. The list gives the approximate avoirdupois weights obtainable by the use of coins just slightly worn :—

20	grs.	= one threepenny-piece.
40	,,	= one sixpence.
43	,,	= one farthing.
61	,,	= half-sovereign.
88	,,	= one halfpenny.
123	,,	= one sovereign.
145	,,	= one penny.
175	,,	= one florin.
218	,,	= half-crown.
$\frac{1}{4}$	oz.	= one halfpenny and one threepenny piece.
$\frac{1}{2}$	,,	= florin and sixpence.
1	,,	= three pennies, or five halfpennies.
1	lb.	= forty-eight pennies.

The United States five cent nickel coin is exactly 5 g. (77 grs.) in weight and 2 centimetres in diameter. The English halfpenny-piece is exactly 1 in. in diameter and weighs, when new, exactly one-fifth of an ounce; the penny is of less convenient weight—one third of an ounce. No halfpenny-piece is issued that is more than ·2 per cent. wrong in weight, one-fifth of 1 per cent. being what is known as the legal "remedy" in weight, and this does not amount to 1 gr. per ounce.

French coins are particularly suitable as metric weights, namely :—

25	g.	=	5	francs	(silver)
10	,,	=	2	,,	,,
5	,,	=	1	,,	,,
$2\frac{1}{2}$	,,	=	$\frac{1}{2}$	,,	,,
10	,,	=	10	centimes	(bronze)
5	,,	=	5	,,	,,
2	,,	=	2	,,	,,
1	,,	=	1	,,	,,

COLAS'S PROCESS

A ferro-gallic printing process perfected by Colas, a German. It is described under the heading "Ferro-gallic Process."

COLD BATH PROCESS (*See* "Platinotype.")

COLD, EFFECT OF

The action of photographic chemicals is seriously retarded by cold, as explained under the heading "Temperatures."

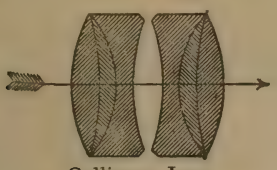
COLD EMULSION (*See* "Emulsion.")

COLLIMATING LENS (Fr., *Collimateur*; Ger., *Kollimatorlinse, Kollimator*)

An achromatic biconvex lens placed in a tube at its principal focal distance from a narrow slit or small aperture. A collimator is used in lens-testing apparatus to produce a parallel beam of light, and in conjunction with the spectroscope. Another form of collimator is a small fixed telescope having cross-wires at its focus; this is employed for adjusting the optical axis, or line of sight, in astronomical instruments.

COLLINEAR LENS

An anastigmat lens introduced in 1894 by Voigtländer, and made in intensities varying



Collinear Lens

from *f*/4·5 to *f*/12·5. The illustration shows the construction of the original type.

COLLOCHROME

Coloured collotype printing.

COLLODIO-ALBUMEN PROCESS

An obsolete process, which gave most beautiful transparencies. A plate is first coated with bromo-iodide collodion, then sensitised in a silver bath and washed to remove excess of silver nitrate. Next it is coated with a mixture of albumen, bromide, and iodide of potassium, which destroys the sensitiveness of the plate so that it can be dried in daylight. When required for use, the plate is resensitised with silver nitrate and thoroughly washed and dried. A gallic acid and silver nitrate developer is generally used. (For working details *see* "Albumen Process," sub-heading "Positives.")

COLLODIO-BROMIDE

(*See* "Collodion Emulsion.")

COLLODIO-BROMO-CHLORIDE EMULSION

(*See* "Collodion Emulsion.")

COLLODIO-CHLORIDE

An emulsion of silver chloride suspended in collodion. Generally used for printing-out papers. (*See also* "Collodion Emulsion.")

COLLODIO-GELATINE (Fr. and Ger., *Collodio-gelatine*)

H. W. Vogel suggested that dry gelatino-bromide emulsion should be dissolved in glacial acetic acid and alcohol, and mixed with a solution of pyroxyline in similar solvents, with the object of combining the advantages of the two processes. The process has found no practical use, as the sensitiveness is very low. Husnik gave the following formula:—

Dry gelatino-bromide emulsion	1 oz.	30 g.
Glacial acetic acid	1 „	30 ccs.
Alcohol	1 „	30 „

Dissolve, and add—

Pyroxyline	2 oz.	60 g.

dissolved in—

Glacial acetic acid	1 oz.	30 ccs
Alcohol	800 mins.	50 „

COLLODION (Fr., *Collodion;* Ger., *Kollodium*)

A solution of pyroxyline in a mixture of equal quantities of alcohol and ether; it should be kept in a well-stoppered bottle. It is a colourless, syrupy liquid, being more or less fluid according to the quantity and nature of the pyroxline used. It will keep indefinitely if made with a good pyroxyline; the pyroxyline should be first well saturated with the ether and then the alcohol added, and, on shaking, the cotton should completely dissolve. The solution should now be set aside in the dark and allowed to stand two or three days to allow any mechanical impurities to settle, this being preferable to filtration, as in this process some of the solvents are lost. The ether used may be the so-called methylated ether, and should have a specific gravity of ·720; the alcohol may be the industrial methylated spirit, but it is preferable to use the pure alcohol; aqueous alcohol should be used when aqueous solutions of salts are to be added to the collodion, as is often the case in making collodio-chloride printing-out emulsion.

Collodion is used for enamelling prints (*see* "Collodion, Enamel") and as the vehicle for the silver salts in the wet-plate process, dry collodion plates, collodion emulsion, and collodio-chloride paper.

It is important that collodion should always have that degree of viscosity which has been found the most satisfactory for the particular purpose. Viscosity may be defined as the thickness or syrupy nature of the collodion. A very thin collodion—that is, one with less viscosity—is apt to allow the silver salts to deposit at the bottom of the bottle; on the other hand, for some purposes—such as enamelling—a less viscosity is advisable. The simplest method of testing the viscosity is by means of Von Hübl's viscosimeter, a glass tube 6 in. (15 cm.) long, 1·2 in. (3 cm.) internal diameter, with one end drawn into a fine aperture of about $\frac{1}{25}$ in. (1 mm.). About $\frac{1}{3}$ in. (8 cm.) from the wide end, and on the outside of the tube, should be scratched a line. This tube should be filled up to the mark with distilled water, the small aperture being covered with the finger, and by means of a stop-watch the time taken for the water to flow out should be noted. The mean of six tests should be taken. Then the same process should be gone through with the collodion to be tested; the time taken by the collodion divided by that taken by the water gives the viscosity of the collodion. For instance, assume the mean for six tests for distilled water at a certain temperature to be 84 seconds, and the time for a specially thick 4 per cent. collodion to be 187 seconds; then $187 \div 84 = 2.226$, the viscosity of the collodion.

The proportion of alcohol and ether is not a fixed quantity. In summer more alcohol should be used, and thus the loss from evaporation slightly checked. For coating large plates a collodion rich in ether is difficult to work, as the solvents evaporate before the plate is covered; on the other hand, a film produced by a collodion rich in ether is tougher. In the wet collodion process excess of alcohol produces greater sensitiveness, whilst in the dry collodion process the ratio of the solvents is of less importance, and certainly in those emulsions washed by precipitation an excess of alcohol is an advantage. The solubility of the silver nitrate and the salts has also considerable bearing on this point, and it may be considered as a general axiom that all

salts are more soluble in alcohol than in ether. More particular details will be found under the special headings.

In process work, collodion is an important factor on account of the facility and cheapness with which, by its help, negatives suitable for the various reproductive processes can be made. The comparative slowness of wet-plate exposures is no drawback where exposures are invariably made by electric light; and the development, fixing, intensification, clearing, and drying are all executed much more quickly than on gelatine plates. The silver deposit being on the surface, the image is more susceptible to intensification and reduction than an emulsion film. Finally, on the ground of cheapness, wet collodion holds the field. It has been calculated that the average cost of making negatives in half-plate size is: Wet collodion, 1d.; collodion emulsion, 1¼d.; dry plate, 2¼d. Collodion is also largely used in process work for stripping. (*See also* conclusion to article "Collodion Process (Wet).")

COLLODION BOTTLE (Fr., *Flacon à collodion*; Ger., *Kollodiumgiessflasche*)

A long, narrow bottle for holding and pouring collodion in the wet-plate process. The earlier patterns had merely an ordinary stopper, but in the modern "cometless" collodion bottle A, so called because its peculiar construction

A. "Cometless" Collodion Bottle

B. Collodion Pouring Bottle and Filter

ensures practical freedom from the comet-shaped spots and other markings incidental to wet-plate work, a closely-ground cap is substituted. A combined pouring bottle and filter is shown at B. A piece of muslin or cotton is tied over the lower end of the inner tube, through which the contents must pass before being poured out. The surplus is returned to the bottle through a notch at the side of the tube. For a third type of bottle, see under the heading "Collodion Filter."

COLLODION EMULSION

A suspension of various silver salts in collodion, and used for printing-out papers, transparencies by development, and negative work. The simplest of all collodion emulsions to make is that for printing-out paper, or, as it is sometimes called, collodio-chloride paper. There are numerous formulæ, but those given in the next column and in the first column of p. 119 have been found of great practical use.

Valenta's Formula

Lithium chloride	0·9 g.
Strontium chloride	1·8 ,,
Absolute alcohol	10 ccs.
Glycerine	10 ,,

Dissolve by the aid of a gentle heat, and add to—

Celloidin collodion (3 %)	950 ccs.

Then add—

Citric acid	5 g.
Warm alcohol	*q.s.*

Enough alcohol should be used just to dissolve the acid. Shake thoroughly, and add:—

Silver nitrate	16 g.
Hot water	20 ccs.

This should be added in small quantities at a time, shaking thoroughly between each addition. Allow the emulsion to stand for twenty-four hours, then filter and use.

Hanneke's Formula

A.	Celloidin collodion (4 %)	620 ccs.
	Ether	100 ,,
	Absolute alcohol	30 ,,

To this add—

B.	Silver nitrate	25 g.
	Distilled water	25 ccs.
	Absolute alcohol	120 ,,

Then add in small quantities, shaking well after each addition and observing the order given:—

C.	Calcium chloride (crystal)	4 g.
	Distilled water	4 ccs.
	Absolute alcohol	30 ,,
D.	Citric acid	5 g.
	Distilled water	5 ccs.
	Absolute alcohol	30 ,,
E.	Castor oil	7·5 ,,
	Glycerine	7·5 ,,
	Absolute alcohol	15 ,,

For solutions B, C, and D, the salts or acid should be dissolved in the water by the aid of heat and then the alcohol added; if this throws down any crystals the solution should be gently warmed, and as soon as clear added to the collodion. In all cases the solutions should be added in small quantities at a time with constant shaking in between, so as to obtain as fine-grained an emulsion as possible.

Silver Bromide Printing-out Emulsion

This was suggested in 1906 by Valenta, and gives an excellent printing-out paper.

A.	Celloidin collodion (3 %)	1,000 ccs.
B.	Citric acid	20 g.
	Absolute alcohol	90 ccs.
	Strontium bromide	3·2 g.
	Glycerine	4 ccs.
C.	Silver nitrate	20 g.
	Hot distilled water	10 ccs.
	Absolute alcohol	80 ,,
D.	Ether	160 ,,

Mix A and B in daylight and add C in the dark-room in small quantities with thorough agitation; add D, allow the emulsion to stand fifteen minutes, and then filter through wool and use for coating. This gives an extremely rapid

printing paper with a long scale of gradation, and therefore requires rather brilliant negatives. An emulsion which is much more suitable for the average negative can be prepared by adding to the B solution :—

Calcium chloride (anhydrous) . 0·5 g.

Greater contrasts still can be obtained by using uranyl chloride or adding calcium chromate.

Collodio-chloride Emulsion for Development

This gives very slow plates, but the grain is exceptionally fine and very warm tones are obtainable.

Magnesium chloride (crystal) . 4 g.
Absolute alcohol . . . 20 ccs.

Rub up in a mortar, and add—

Collodion (2 %) . . . 50 ccs.

As soon as the mixture becomes slimy, add—

Ether . . . . . 30 ccs.

And finally add—

Nitro-hydrochloric acid . . 0·6 ccs.

The silver collodion is prepared as follows :—

Silver nitrate . . . 4 g.
Hot distilled water . . 3 ccs.

When dissolved, add—

Hot alcohol . . . . 20 ccs.

And then—

Raw collodion (2 %) . . 50 ccs.

The chloride collodion should be added to the silver collodion in small quantities, well shaken, and allowed to stand for twenty-four hours with occasional agitation ; then it should be poured in a fine stream into about sixteen times its volume of warm water (100° F., or nearly 38° C.) with constant stirring. The emulsion is precipitated in fine flocks, which should be collected on a clean linen filter, gently squeezed, and then well stirred up with warm water two or three times and finally well drained, rinsing once or twice with alcohol. Five parts of the dried emulsion should be dissolved in 100 parts of a mixture of equal volumes of alcohol and ether, shaken till dissolved, and then filtered.

Pure bromide and chloro-bromide collodion emulsions were much used for transparency making, but of recent years the gelatine lantern plates have completely ousted them from practical use. They are, however, now employed for negative work, and the most satisfactory formulæ are those given by Von Hübl.

Collodio-bromide Emulsion

Silver nitrate . . . 50 g.
Distilled water . . . 50 ccs.

Dissolve, and add liq. ammoniæ (·880) in sufficient quantity to form a perfectly clear solution ; allow to cool, and add the silver solution to—

Collodion (4 %) . . . 600 ccs.

This should be in a large bottle, preferably one that will contain about three times the total volume, and if any of the cotton or silver settles out no notice need be taken of it. To this silver collodion add the following, whilst still warm :—

Ammonium bromide . . 32 g.
Hot distilled water . . 35 ccs.
Alcohol . . . . 50 „

Shake the emulsion for about five minutes, and then add in small quantities with vigorous agitation about one-fourth of its volume of distilled water. This causes the emulsion to precipitate. It should then be poured into about ten times its bulk of water and well stirred, the water drained off, and the washing repeated three or four times. The shreds of emulsion are finally collected on a linen filter, and gently pressed ; then shaken up with alcohol, and again pressed out. The emulsion shreds should now be shaken up with 8¾ oz. or 250 ccs. of absolute alcohol, and allowed to stand for twenty-four hours ; at the end of this time 5¼ oz. or 150 ccs. of the liquid should be poured off and replaced by 5¼ oz or 150 ccs. of absolute alcohol in which 7½ grs. or 0·5 g. of narcotine have been dissolved, and 8¾ oz. or 250 ccs. of ether added, well shaken, and allowed to stand three days and then—

Absolute alcohol . . . 250 ccs.
Ether . . . . . 250 „

added and the emulsion filtered.

Chloro-bromide Emulsion

This can be made in precisely the same way as described above by reducing the ammonium bromide to 416 grs. or 27 g. and adding 23 grs. or 1·5 g. of pure anhydrous lithium chloride. Both these emulsions are very suitable for positive work and also for sensitising with eosine and other dyes for colour negatives.

Von Hübl recommends a glycin developer, but hydroquinone is the general favourite. Collodion positives and negatives can be intensified, reduced, or toned like any other silver images.

In process work, collodion emulsion has been revived of late years because of its suitability for colour work, owing to the emulsion being susceptible to colour sensitising with aniline dyes. A chloro-bromide emulsion is used for this purpose, and it is always exposed in the moist state. The sensitising dyes are sometimes added to the emulsion, and in other cases flowed over. Excellent emulsions are on the market.

COLLODION, ENAMEL

A mixture used for giving to prints the highest possible gloss, the process being called enamelling, an expression sometimes incorrectly applied to burnishing and rubbing with encaustic paste. Enamel collodion may be purchased ready for use, or may be made according to the following formula :—

Pyroxyline . . . . 4 grs.
Methylated alcohol . . ½ oz.
Methylated ether . . ½ „
Castor oil . . . . 4 drops

(For methods of using, *see* "Enamelling Prints.")

COLLODION FILTER (Fr., *Filtre à collodion ;* Ger., *Kollodiumfiltrierflasche*)

An arrangement for filtering the collodion used in the wet-plate process. As here shown,

a tuft of cotton is adjusted loosely in the lower part of the bulb-shaped receptacle at the top, the collodion being poured into this and filtering into the bottle beneath. A glass tube runs

Collodion Filter

from top to bottom to allow of the escape of air as the filtered collodion ascends; this tube should be kept above the surface of the solution as the filtering proceeds. (*See also* "Collodion Bottle.")

COLLODION PELLICLE

A preparation, advertised and described by W. B. Bolton in 1876, for making sensitive plates which could be used in a dry or wet state.

COLLODION POSITIVE

A collodion negative image taken on thin, black-surfaced metal or on glass backed with velvet or black varnish. By reflected light the image appears as a positive. Collodion positives are usually made by the wet-plate process (*see* "Collodion Process (Wet)"). A thin image being necessary, the collodion should be diluted and development stopped directly the details are out. An iron developer gives the whitest deposit, and allows a shorter exposure to be given. Except when taken with a reversing mirror or prism in front of the lens, the ferrotype image is laterally reversed—that is, the left hand of the sitter appears as the right hand in the picture. The following developer gives an exceptionally white deposit suitable for ferrotypes, etc. :—

Potassium nitrate .	200 grs.	22·8 g.
Ferric protosulphate .	300 ,,	34·2 ,,
Acetic acid (glacial) .	1½ oz.	75 ccs.
Nitric acid (pure) .	30 mins.	3 ,,
Water . . .	20 oz.	1,000 ,,

Collodion positives must be varnished or glazed, as otherwise the film is abraded by handling.

COLLODION PROCESS (DRY)

In this process plates and papers coated with a collodion emulsion (*which see*) are employed, thus obviating the great disadvantage of the older wet process in which the plates had to be exposed immediately they came from the sensitiser. Full information on preparing the emulsion is given under the heading to which allusion is made above. Generally, collodion plates are of about the same speed as lantern plates, and they can be developed with any standard solutions used for gelatine dry plates. Glycine is particularly recommended owing to its freedom from fog.

COLLODION PROCESS (WET), OR WET-PLATE PROCESS (Fr., *Procédé à la collodion humide, Collodion mouillé;* Ger., *Kollodiumverfahren, Nasses kollodionverfahren*)

Collodion was introduced into England in 1847; immediately afterwards R. J. Bingham (one of Faraday's assistants) suggested its use for photography. Gustave Le Gray, a noted French worker, also suggested that collodion might prove useful. The actual invention of the first workable process is due, however, to F. Scott Archer, who made the first collodion negatives in the autumn of 1848, and who published his perfected process in the *Chemist* for March, 1851. So popular did Archer's process become that it practically displaced daguerreotype and calotype, and it was almost exclusively used between 1855 to 1881. It is largely used to-day by process workers and by itinerant photographers; while for certain other branches of photography—lantern slides, for example—it is considered by many to be unsurpassed. Its chief advantages are a structureless film, an extremely fine grain, and clear whites. The fixing agent is easily washed out of the film, and the negative can be dried by heat. Wet-plate negatives can also be easily reduced and intensified.

Wet plates are of low sensitiveness, their speed being about the same as that of lantern plates.

The photographer must prepare his own plates. A deep porcelain dish for the silver bath, a size larger than the plate to be sensitised, is required; it must be scrupulously clean, and if it has previously contained other chemicals it must be very thoroughly washed. Place 480 grs. of silver nitrate in a clean pint bottle, and add 15 oz. of distilled water (rain or tap water will not do). Shake until dissolved, and add 3 drops of pure nitric acid. Keep a day or two before using.

Each ounce of the silver bath contains 32 grs. of silver nitrate, and the strength should be kept as near this as possible, using, if necessary, an argentometer for testing the density. The silver bath is filtered, poured into the porcelain dish, covered with a piece of cardboard, and placed in the corner of the dark-room that is farthest from the developing sink. Adjust the dark-room lamp so that a good light is thrown on the dish. Wet plates will stand far more red or yellow light than dry plates.

For coating the glass the following are necessary :—(*a*) A 4-oz. bottle of Mawson's collodion, with iodiser in a separate bottle. Before use the iodiser is poured into the collodion, and this iodised collodion will keep in good condition for several months, becoming deep red in colour, the plates then requiring a much longer exposure. Iodised collodion can be purchased ready for use, but the plan here described is preferable. (*b*) Rubber solution for edging the plate.

For developing, fixing, etc., obtain :—

Pyrogallic acid . . .	1 oz.
Glacial acetic acid . .	4 ,,
Ferric protosulphate . .	1 lb.
Mercuric bichloride . .	1 oz.
Liquor ammoniæ . . .	1 ,,
Lead nitrate . . .	1 ,,
Potassium ferricyanide . .	1 ,,
Sodium hyposulphite or potassium cyanide . . .	1 lb.

Before coating with collodion, the plate is "edged" to prevent the film from leaving the glass. A drop of rubber solution is taken up on a piece of cotton-wool and run round the edge of the glass, and the plate is then ready for coating.

Take the glass at one corner between the finger and thumb, and pour a small pool of collodion upon it. Carefully tilt the glass so that the collodion flows to the corner farthest from the fingers, tilt again into the other top corner, next bring the collodion to the corner nearest the thumb, and then pour the surplus back into the bottle via the remaining corner. While the collodion is being poured into the bottle the plate must be kept moving to and fro laterally, or the collodion will set in ribs. This movement of the plate must be continued for several seconds, till the collodion is set. Replace the stopper in the collodion bottle, close the door of the dark-room, and immerse the plate in the sensitising solution.

When placing the plate in the silver bath, the dish should be tilted, so that the solution flows to one end. Place the plate in the other end of the dish, and immediately lower the dish to let the bath flow in an even wave over the plate. If the flow is checked, a streak across the image will result on development. The cover of the dish is now replaced, and the door of the dark-room can be opened for a minute or so.

Sensitising begins directly the plate is inserted in the bath, and is complete in about two and a half minutes. The plate is ready to be removed from the bath when the film presents a creamy appearance; but, as a rule, leaving the plate in the bath for two or three minutes will suffice. Of course, if it is desired to look at the plate while in the bath the door of the dark-room must be closed.

If ordinary dry-plate slides are to be used the rebates for the glass must first be covered with strips of blotting-paper. If the wet plate touches the woodwork of the slide, scum will form over the plate and the picture will be spoilt. If the strips of blotting-paper are damped before use they can easily be fixed in the rebate. Wet-plate slides are provided with silver wires with the object of supporting the plate, but even these slides require blotting-paper at the bottom and top of the plate. After remaining in the bath for two or three minutes the plate is removed by being raised with the handle of a silver spoon, or with a lifter made of horn or vulcanite. The fingers must not be dipped into the silver bath, and neither wood nor metal, other than silver, must be used. The collodion of the sensitised plate has a creamy, opalescent appearance, owing to the formation of silver iodide in the film.

The plate is allowed to drain for a few seconds over the bath, and the moisture is then removed from the back with a piece of blotting-paper, the plate meanwhile resting on its edge upon a sheet of clean paper.

Next, the plate is inserted in the dark-slide, care being taken that the collodion film is not in contact with either wood or metal. The exposure for wet plates is from ten to twenty times longer than is required for an ordinary dry plate; fresh collodion requires less exposure than stale, and in cold weather the sensitiveness of the film is considerably diminished. In a weak light or in a slightly yellow one a wet collodion plate is far less effective than a gelatine film.

An acid, instead of an alkaline, developer is necessary for wet collodion plates. The following is a formula for a pyro developer stock solution:—

Pyrogallic acid . . .	24 grs.
Glacial acetic acid . .	2 oz.

This solution keeps well. For use, add 6 parts of water to 1 part of the stock solution.

The above is quite reliable, but some workers prefer ferric sulphate, as in the following:—

Ferric protosulphate . .	1 oz.
Glacial acetic acid . .	1 ,,
Water	15 ,,

Methylated spirit should be added to the developer after the bath has been in use some time, to ensure even flowing of the solution over the plate. A shorter exposure is required for iron development. Developing and fixing dishes are not required. The plate is removed from the dark-slide, and the developer is poured quickly and evenly over the film. The plate is kept moving during development, in order to keep the film covered with solution. Fresh developer must be used for each plate. The image develops steadily, and usually begins to appear in about ten seconds; but in cold weather the time may be considerably longer. Development is stopped when all the details are visible. The plate is washed for a few seconds under the tap and is then fixed with potassium cyanide, which should be kept in a saturated solution, and for use diluted with double its volume of water.

"Hypo" can be used instead of cyanide; but it does not work so quickly, and takes longer to wash out of the film. After fixing with potassium cyanide, the plate is washed for a minute or so under the tap; if "hypo" is the fixing agent, five minutes' washing is necessary. If the picture is satisfactory, the plate can be dried in front of the fire. The collodion image, when fixed, should be bright and clear, without a trace of fog or stain. The best reducer, should one be found necessary, is cyanide and iodine, made by dissolving a few crystals of iodine in methylated spirit and adding a saturated solution of potassium cyanide until the red colour of the iodine has disappeared.

If intensification is required, a solution of mercuric bichloride, followed by ammonia, can be used as in dry plate operations. If the image is very flat, or when black-and-white work is required, intensification with lead nitrate can be adopted, using:—

Lead nitrate . . .	1 drm.
Potassium ferricyanide . .	1½ ,,
Water	10 oz.

The plate is immersed in the above solution till sufficient density is reached, then washed under the tap till all yellowness has disappeared. The picture, in most cases, need not be blackened when intensified by lead, as sufficient density is obtained without the use of an alkali. When absolute opacity is required, ammonium hydrosulphuret can be used, after all the yellow stain

has been washed from the film. It must be noted that the lead intensifier has a drastic action and must be used only for flat pictures or for the reproduction of black-and-white drawings.

Another method of intensification, known as re-development, is perhaps the best for beginners. When the image, after fixing, seems to be lacking in contrast, the plate is rinsed and fresh developer, mixed with a few drops of a 10 per cent. solution of silver nitrate, is flowed over the film. The addition of the silver to the developer gives vigour to the image. After fixing the plate, mercuric intensification will give further contrast, if necessary. When dry, the plate should be varnished, as the collodion film is easily torn.

For ferrotype plates, a thinner film is necessary, and the iodised collodion should be further diluted with sulphuric ether. A developer giving a white deposit (*see* "Collodion Positive") should be used. The general procedure of sensitising, developing, and fixing ferrotypes is the same as for wet-plate negatives.

In process work, a very clean working collodion is required, and at the same time one that gives great density. Further, the film must be tough to withstand intensification and reduction. Celloidin collodion of not more than 2 per cent. strength is usually employed. Pure solvents have to be used in order to avoid fog and scum. Ammonium and cadmium iodide and cadmium bromide with cadmium chloride are the general ingredients of the iodiser. A typical formula for collodion suitable for process work is—

Celloidin . . .	1 oz.	31 g.
Alcohol (·805) . .	40 ,,	1,136 ccs.
Ether (·720) . .	60 ,,	1,704 ,,

The following is the iodiser:—

Alcohol (·820) . .	10 oz.	284 ccs.
Cadmium iodide .	½ ,,	15.5 g.
Ammonium iodide .	180 grs.	11·6 ,,
Cadmium bromide .	15 ,,	1 ,,
Cadmium chloride .	30 ,,	2 ,,
Iodine . . .	10 ,,	·6 ,,

Take one part iodiser to nine parts collodion, and allow to stand for ten to fourteen days. The silver bath is usually 35 to 40 grs. per oz. Development is with the iron developer; fixing with potassium cyanide; intensification with either lead nitrate (for line negatives), or with copper bromide (for half-tone), followed with ammonium or sodium sulphide. "Cutting" or reducing to sharpen up the dots or lines is generally resorted to, the solutions employed being iodine and cyanide. For stripping, the negatives are coated with rubber solution and then with collodion to which a small proportion of castor oil has been added to make it flexible. The glass plates are, as a rule, edged with rubber solution before coating with collodion, to make the latter hold.

COLLODION TRANSFERS

Collodion positives transferred from the original glass to other supports, usually paper. Special collodions and papers for transfer work are now commercial articles, and the process is quite easy nowadays, compared with what it was in 1857, when it was first practised no special collodions for the purpose being then obtainable. A suitable transfer paper is made by evenly coating smooth-surfaced cream-wove foolscap with a solution of gelatine made by dissolving ½ oz. of gelatine in from 20 to 30 oz. of water, and then drying. After the collodion picture is fixed and washed in the usual way, the transfer paper is soaked and carefully squeegeed into contact with the picture, film to film, and allowed to dry. When dry, one corner of the paper may be lifted with a penknife, when it will strip from the glass and bring the picture with it. If the pictures to be transferred are large, the glass should be coated with a substratum of wax before the usual collodion is applied. Five grains of pure sun-bleached white wax in 1 oz. of ether forms the waxing solution; this is spread evenly and rapidly over the glass, and, when dry, polished until no trace of the wax apparently remains, although enough will be left to assist the picture to leave the glass easily. In some cases, negative films, too much under-exposed to print from, were bleached by means of mercury and transferred to black paper, on which they appeared to be positive and finished pictures.

COLLODIONISED PAPER

A term somewhat loosely applied to collodio-chloride paper.

COLLODIOTYPE

An early name for any kind of photograph produced by the collodion process.

COLLOGRAPHIC PROCESSES

A general term applied to collotype methods, all based on the principle of the action of light on a bichromated colloid, the latter being usually gelatine.

COLLOGRAPHY

A process said to have been invented by Pumphrey, of Birmingham, in 1880, and similar to that formerly well known under such terms as "Autocopyist," etc., in which a film of gelatine on glass or on some flexible support, such as parchment, was bichromatised and dried. Writing or drawing is done on a suitable paper with solutions of iron salts, nutgalls, or similar substances having a tanning action on the gelatine surface, to which the design is next transferred. By keeping the gelatine pad moist and applying an ink roller, the lines will take the greasy ink, but the white parts will repel it. Paper is then brought into contact with the pad, and an impression taken by rubbing or squeegeeing.

COLLOGRAVURE

A kind of collotype invented by Balagny, of Paris, in 1893-4, in which gelatino-bromide of silver films were converted into collotype printing surfaces, the prints being made with fatty ink.

COLLOIDS

A name derived from Greek *kolla* (glue) and *eidos* (appearance), and given by Graham to those non-crystalline substances which do not diffuse through porous membranes. The chief organic colloids are cellulose, starch, dextrine, tannin, gelatine, caramel, and albumen. The

inorganic colloids are hydrated oxides of iron, hydrated silica, alumina, etc.

Graham, in 1861, discovered that many substances, particularly those which readily crystallise, diffuse through animal membranes, whilst other substances, such as gelatine, which do not crystallise, do not so diffuse. (Modern researches have shown that Graham's conclusions must be modified somewhat.) The latter class of bodies he called "colloids." The diffusion of the crystalline salts through a membrane he termed "dialysis," and the vessel in which the solution was placed a "dialyser." There are a great many natural or organic substances, such as starch, dextrine, gums, albumen, caramel, rubber, resin, etc., which are colloids and behave precisely in the same way as the first-mentioned gelatine; but there are also many inorganic chemicals, such as ferric hydrate, silicic acid, etc., which act similarly. Apparently these dissolve in water, but when submitted to the test of dialysis prove themselves to be true colloids. The apparent solutions of such substances are called "pseudo-solutions," to differentiate them from the so-called true solutions.

Graham also discovered that water was not unique in forming colloidal solutions, but that alcohol, benzole, glycerine, and sulphuric acid, as well as other solvents, were capable of acting in the same way; and the term "sol" is used to designate these. Thus, hydrosol indicates a water sol, alkosol an alcoholic sol, and glycerosol a glycerine colloidal sol. Generally, when the solution is of an organic nature, it is termed an "organosol."

The scientific student may here be told that, practically, a sol or colloidal solution consists of two ingredients, a liquid and a solid, the latter being in an extremely finely divided state, distributed or suspended in the liquid. The sharply separated parts of the sol are said to be its phases, and in colloidal solutions there are several multiple-phase or heterogeneous formations, and the one phase, being in an extremely finely divided state, naturally presents to the second phase a very large surface, and with normal examination the sol appear perfectly homogeneous. This is called "microheterogeneity." Many substances, particularly those which form jellies or "gels," do not, however, show this particular form of heterogeneity, particularly when coagulation is effected, and then it is termed "macroheterogeneity." In continental literature, the term "disperse-heterogene" is used for the former, and a generic term of "dispersoids" is used for all microheterogeneous systems. Other colloid solutions take another form, and this has been likened to a sponge, that is, they practically form a network distributed throughout the dispersion medium.

The density of colloidal solutions cannot be calculated from the densities of the disperse phase and the dispersion medium, or the substance and solvent; for instance, a solution of a given quantity of gelatine in a given quantity of water is not the sum of their respective volumes, but less, a small but marked contraction taking place. Their osmotic pressure is very low, and in many cases not to be detected, and their boiling and freezing points vary but very slightly from those of the liquid, water, alcohol, etc.

It has been already stated that colloids would not diffuse through an animal membrane, but recent researches have shown that this is only partially true, and that some colloids will diffuse as well as crystalloids, but at a much slower rate, so that the fundamental difference is in their rate of diffusion.

Provided that the size of the particles of the disperse phase are sufficiently small, they exhibit under a powerful microscope peculiar vibratory motions, which were first discovered by Brown in 1827, and are therefore called "Brownian movements." This motion is approximately a zig-zag or to-and-fro motion, and has been ascribed to the contrary pull of gravity and the viscosity or thickness of the liquid. Particles which are larger than 3 to 5 μ (1 μ = ·001 millimetre = $\frac{1}{25400}$ in.) do not show this movement. Many hydrosols appear perfectly clear and homogeneous, but others exhibit the phenomena of fluorescence or opalescence when illuminated by suitable light, and Tyndall's phenomenon is often apparent with light of very small wave length, that is to say, the particles are sufficiently large to reflect violet or ultra-violet light of extremely short wave length, and polarise it. This is the foundation of ultramicroscopy.

The disperse phase carries a positive or negative electric charge, which is dependent to some extent on the dispersion medium—that is, the water or other liquid—and sometimes on its alkalinity or acidity. Colloidal solutions can exhibit a change of condition under mechanical action, or the application of heat, and the dissolved substance may separate in an insoluble form or be converted into jellies by the addition or certain substances, such as electrolytes. When the substance separates out in an insoluble form it is known as a "gel," and if formed from an aqueous solution it is known as a "hydrogel," an "alkogel" from alcohol, and a "sulfogel" from sulphuric acid, etc. The process of the formation of the gel is called pectinisation or coagulation. When the residue left after coagulation is soluble in water, the process is said to be reversible; if insoluble, it is irreversible. Frequently an insoluble and otherwise irreversible colloid is precipitated in the presence of a reversible colloid; it also becomes reversible; and the colloid that produces this state is known as a protective colloid, or, to use the German word, a "schutz-kolloide." Lottermoser has also pointed out that by certain precipitating agents a colloid may be precipitated from the hydrosol in such a condition that it will again form a hydrosol, and therefore suggests the terms "solid" and "liquid" hydrosol, and confines the term hydrogel to the insoluble amorphous substance. The law is that sols with opposite electric charge precipitate one another, but those of like charge do not.

Gels or jellies may be considered as colloid solutions in which the disperse phase is in a higher concentration, and molecular and colloidal solutions can diffuse through a gel more or less rapidly, according to the concentration of the disperse phase of the gel.

Colloidal solutions differ from true solutions in that the latter are perfectly homogeneous under the most critical visual examination that can be applied, whilst the former show the

particles under sufficiently high power as already pointed out. They differ also from suspension liquids or mixtures in that in the latter the particles or disperse phase are sufficiently large to be seen with the naked eye or a weak power. There is, however, some evidence to prove that these divisions are but arbitrary, and that so-called true solutions may be of a colloid nature.

P. Weimarn and Wolfgang Ostwald ("Grundriss der Kolloidchemie") considering that, as suspensions, colloidal and true solutions are merely varying degrees of dispersion, have proposed the name of "dispersoids," and the latter divides them into (1) coarse dispersions, such as suspensions and emulsions; (2) colloidal solutions; (3) molecular dispersoids; and (4) ion-dispersoids, assuming that free ions exist. The crystalloid solutions belong to classes (3) and (4). The above classes merge one into the other, and colloidal solutions are divided into suspension colloids and emulsion colloids, which are also termed suspensoids and emulsoids. The occurrence of colloidal silver and gold is assumed in many photographic processes, and many reactions can only be satisfactorily explained on this assumption. There is, however, an increasing tendency to drag the phenomena of colloids into every obscure photographic process, and there is the grave danger that it may be used merely to cloak our ignorance of the true state of affairs.

COLLOTYPE (Fr., *Phototypie;* Ger., *Lichtdruck*)

A process known also as "phototype," and, in slight variations, as "Albertype," "Artotype," etc. It is based on the principle that if a film of bichromated gelatine is exposed to light under a negative, and the unaltered bichromate is washed out, the film will have a similar property to that possessed by a lithographic stone of attracting ink in some parts and absorbing water in others, the water repelling the ink. It differs essentially, however, from lithographic work in the fact that the attraction for ink and water in the different parts is proportionate to the action of the light, so that the strength of the ink image varies in proportion to the light and shade of the picture. The discovery of this property was made by Fox Talbot in 1853, and his researches were followed up by A. Poitevin, of Paris, from 1856 onward. The first practical collotype process was introduced by Tessié du Motay and Ch. R. Maréchal, of Metz, in 1865; and the perfection of the present-day process of collotype is due to the labours of Josef Albert, Husnik, and Obernetter. Although the process is still largely worked, its commercial success has been much retarded of late years by the progress of halftone, photogravure, and other etching methods, and it has to a considerable extent fallen into disfavour, especially in England and America.

The general method of working the process is as follows:—A thick glass plate is ground on one side with fine emery powder, and is then placed on a levelling stand or levelling screws, and having first been coated with a suitable substratum and dried, is flowed over with a measured quantity of bichromated gelatine. When the film is set the plate is placed in a drying oven, which is brought up to a temperature not higher than 130° F. (54° C.), at which the drying takes about two hours. When cool, the plate is placed with the negative in a special printing frame, pressure being applied by wedges. The plate is next washed to remove the unaltered bichromate, and allowed to dry. To prepare the image for printing, the surface is flooded with a mixture of glycerine, water, and sometimes other ingredients, allowing it to stand for thirty minutes. Then the excess is removed and the plate is rolled up with a lithographic roller charged with a special collotype ink, which is similar to lithographic ink, but stiffer. When completely inked, paper is laid on the plate and pressure applied in a press. An ink image reproducing the tones of the original is thus obtained. Success depends on the proper formation of a grain caused by reticulation of the gelatine during the drying, and the grain is modified by exposure according to the action of the light passing through different parts of the negative.

Many modifications of detail have been made by different workers, but the above general outline applies to all the methods, except that in some cases attempts have been made to form the image on aluminium, copper, lead, and other plates instead of glass.

Collotype in colours has been worked with success for some years in Germany, and to some extent in England. The number of negatives made varies with the number of different colours required. A collotype plate is made from each negative, and all its parts are blocked out except those required for that particular colour. The printing is then done as in chromo-lithography, the impressions of each colour being superimposed in exact register.

COLOPHONY (Fr., *Colophane;* Ger., *Colophonium*)

Another name for resin, more used on the Continent than in England. Properly it is applied to a black resin, the solid residuum of the distillation of turpentine after the oil has been worked off. (Particulars of resins are given under the heading "Gums and Resins.")

COLORIMETER (Fr., *Colorimètre;* Ger., *Farbenmesser*)

An instrument for ascertaining the strength or purity of a substance by comparing its colour with a given standard. There are several forms, as, for example, Mill's, in which the colour is varied by altering the depth of a tinted solution until a match is obtained; Lovibond's, in which a number of coloured glasses are adjusted; and so on. A colorimeter is occasionally useful in photography, as, for instance, in the volumetric estimation of silver nitrate solution with potassium chromate, in which it is often difficult to recognise the red reaction that ensues owing to the original yellow colour of the test solution itself. A properly adjusted colorimeter renders the change of tint at once manifest.

COLOUR (Fr., *Couleur;* Ger., *Farbe*)

A person sitting in a perfectly dark room can see neither the form nor colour of the objects around him; but the moment light is admitted

TABLE OF SUBTRACTIVE COLOUR MIXTURES OR SUBTRACTIVE ANALYSIS (STOLZE)

Orange	*Yellow*	*Yellow green*	*Green*	*Blue green*	*Cyan. blue*	*Indigo blue*	*Violet*	
							Bluish violet	Indigo blue
						Blue	Blue violet	Cyan. blue
					Greenish blue	Greenish blue	Bluish grey	Blue green
				Bluish green	Blue green	Blue green	Grey	Green
			Yellowish green	Green	Bluish green	Green	Violet grey	Yellow green
		Greenish yellow	Yellow-green	Yellow green	Green	Yellowish olive	Dirty red brown	Yellow
	Gold yellow	Olive	Yellowish grey	Yellowish grey	Olive grey	Olive	Red-brown	Orange
Deep red	Yellowish red	Greyish yellow	Yellowish grey	Grey	Grey violet	Greyish brown	Dirty red violet	Deep red
Deep red	Scarlet	Yellowish grey	Grey	Bluish grey	Bluish violet	Violet	Red violet	Purple

he at once sees the shape of objects and also their colours. It is obvious then that to have colour there must be light. Colour is due to the suppression or absorption of some of the constituent rays of white light (*see* "Spectrum"). A sheet of red glass looks red because it has suppressed or absorbed that particular region of the spectrum or those colours to which red is complementary (*see* "Colour, Complementary"), and it is the residuary colours that give the observer the impression of red. Precisely the same thing happens with any substance which is not transparent, as, for instance, a sheet of red paper or a green leaf; the light incident on its surface penetrates to a slight depth into the substance of the paper or leaf, and there meets with a material or surface which reflects the light back to the eye, but in its passage into and out of the paper or leaf the light undergoes selective absorption, and the residuum of the incident light now appears either red or green.

White, grey, and black are not colours; the first is the sum of all the spectral rays; grey is all the rays reduced in intensity; whilst black is the suppression of all light, and therefore of all colour. This can be strikingly illustrated by projecting a spectrum or a series of coloured glasses or filters on to a white, a grey, and a black surface. In the first case, all the colours are seen in their original purity and strength, whereas in the case of the grey surface, the colours are still there, but they are reduced in luminosity, that is, they appear less brilliant. With a black surface, such as good black velvet, the colours are absorbed entirely.

Colour may also be formed by the interference of the light rays with one another, but this is also a suppression of some of the spectral rays. (*See* "Interference of Light.")

It is usual, therefore, to designate colours as "body colours" and "surface or interference colours." To the former class belong all coloured pigments, and to the latter those colours seen on a diffraction grating, a thin soap bubble or a peacock's tail feathers.

It is important to differentiate between the action of mixed pigments and mixed lights, as the results are not comparable. In the former case, mixing increases in each case the suppression or absorption of light with each pigment used, whereas the mixing of coloured lights adds light to light. To illustrate the first point, take three printing inks, red, yellow, and blue, such as are used in trichromatic printing, and examine the absorption spectrum of each. The letters at the top of the diagram refer to the Fraunhofer lines, the colours being placed underneath; the black portions show the assumed absorptions of the inks, whilst the white portions show the

TABLE OF ADDITIVE COLOUR MIXTURES OR OPTICAL SYNTHESIS (HELMHOLTZ)

	Violet	*Indigo blue*	*Cyan. blue*	*Blue green*	*Green*	*Greenish yellow*	*Yellow*
Red	Purple	Dark crimson	Whitish crimson	White	Whitish yellow	Golden yellow	Orange
Orange	Dark crimson	Whitish crimson	White	Whitish yellow	Yellow	Yellow	
Yellow	Whitish crimson	White	Whitish green	Whitish green	Greenish yellow		
Greenish yellow	White	Whitish green	Whitish green	Green			
Green	Whitish blue	Water blue	Blue green				
Blue green	Water blue	Water blue					
Cyan. blue	Indigo blue						

light reflected, the sum of which is severally red, yellow, and blue. Now, it is obvious that by superimposing these three spectra there is no part which is transmitted by all three, and the result is total absorption of light, or black. Taking the case of three-coloured lights, by mixing them on a screen by means of a triple lantern, just the reverse of the above effect is obtained; for convenience, let there be taken red, yellow, and blue glasses, matching approximately the inks referred to above. Then, considering not the absorptions or black portions, but the white or transmitted portions in the figure, it will be understood that the whole spectrum is transmitted and the result is white light.

The former is called subtractive colour mixing or analysis, whilst the latter is termed additive colour synthesis. It must not be overlooked that whilst pigmentary colours have been dealt with, in the case of subtractive colour analysis, the argument applies also to superimposed transparent colour filters.

The tables on the preceding page show the difference between the two systems.

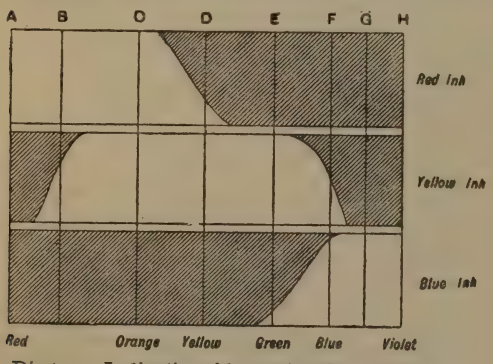


Diagram Indicating Absorption Spectra of Red, Yellow and Blue Printing Inks

In these tables the colour resulting from a mixture of any two colours is found where the vertical and horizontal colours meet. Also, the term "whitish" means that the colour appears pale—that is, mixed with white light. It is usual to designate the main or predominant colour and precede it by the colour with which it is mixed; for instance, there may be a full or pure green; when mixed with blue, this becomes bluish-green; with still more blue, a pure blue-green; with increasing quantity of blue, it becomes greenish-blue.

COLOUR ABSORPTION

Whilst colour itself is an absorption of light (*see* "Colour"), it is extremely important in some cases to know the colours absorbed by certain materials, such as aniline dyes for filter making. The only method of determining this satisfactorily is by means of a spectroscope, or, for accurate work, a spectro-photometer. It is laborious work, as the absorption of a dye solution will alter with increased concentration or depth of solution, and it is necessary, therefore, to make very careful spectro-photometric observations at various dilutions. This, however, can be performed much more readily by photography, as has been done by Uhler and Wood, of the Carnegie University, of Washington, U.S.A., and more completely by Wratten and Wainwright in their "Atlas of Absorption Spectra," which contains the absorption spectra of 170 dyes. For this work was used a small box spectrograph fitted with a prism grating, and the dye solution was contained in a wedge cell of rectangular form of 1 cm. (·4 in.) internal length and 5 mm. internal width, with a diagonal partition which divided it into two wedge-shaped cells, the one being filled with the dye solution and the other with the solvent, so as to obviate the prismatic effect of the cell. The thickness of the dye solution thus varied considerably, the actual thickness from end to end of the slit being about 1 to 15. The spectrograph was provided with a wave length scale and an ultra-violet filter. Precisely the same results can be obtained by using a parallel-sided cell of fixed width and varying the strength of the solution, or keeping the dye strength constant and varying the cell width, but these plans are laborious and do not give the required information in such compact form.

COLOUR, COMPLEMENTARY (Fr., *Couleur complémentaire;* Ger., *Komplementärfarben*)

For every saturated and unsaturated colour there exists another colour which, when suitably mixed with it, forms white; such pairs are called complementary colours. It is important to know—roughly, at any rate—the complementary colours, because one can at once determine the colour of the filter required to absorb one or the other. For instance, supposing one had to photograph a photomicrographic object which was stained green and blue in parts, and it was desired clearly to differentiate the green; then all one would require to know would be the complementary colour to green, and a filter of that colour would absorb the green and show it as black. On the other hand, if one wanted to show the green and suppress the blue-stained portions, then one would only require to know the complementary colour to the blue to absorb this and render the green clear.

The following table, compiled by Prof. Grünberg, of Vienna, contains the sum of the observations of the leading physicists of the day:—

Colour	*Wave length in μμ*	*Complementary colour*	*Wave length in μμ*
Red	656	Greenish blue	492
Orange	608	Blue	489
Gold yellow	585	Blue	483
	576	Blue	472
Yellow	571	Indigo blue	462
	566	Indigo blue	447
Greenish yellow	564	Violet	433

He also gives the following very simple formula for finding approximately the complementary colour:—

$$L' = 498 - \frac{424}{L - 559}$$

in which L' = the complementary colour and

L the given wave length. Ex.—What is the complementary to wave length 589 ?

$$L' = 498 - \frac{424}{589 - 559}$$

$$= 498 - \frac{424}{30} = 498 - 14{\cdot}13 = 483{\cdot}87$$

There is no true spectral colour complementary to the pure green spectrum region ; this is found in the purples or crimsons made by a mixture of violet and red. (*See also* "Zander's Complementary Colour Process.")

COLOUR, EFFECT OF

The effect of the various colours on the photographic emulsion is dependent chiefly on whether the emulsion is colour-sensitised or not, on the use of colour filters, and the length of the exposure. The ordinary (non-colour-sensitised) plate is sensitive to the ultra-violet, violet and blue rays, the commercial iso- or orthochromatic plate has an added sensitiveness to yellowish-green and yellow, whilst the panchromatic plate has red sensitiveness as well.

There is one effect of colour which is particularly marked when using screenplates, and that is the effect of reflections from surrounding coloured objects on a sitter or object. When dealing with ordinary monochrome photography this is entirely overlooked, but with colour reproductions these coloured reflections obtrude themselves sometimes in the most unexpected manner.

COLOUR FILTER

(*See* "Colour Screen or Filter.")

COLOUR FOG

(*See* "Fog, Colour.")

COLOUR, FUNDAMENTAL

(*See* "Colour Sensations.")

COLOUR PHOTOGRAPHY

(*See* "Autochrome Process," "Ives' Process," "Lippman's Process," "Screenplate Colour Photography," etc.)

COLOUR, POSITIVES IN

(*See* "Positives in Colours.")

COLOUR SCREEN OR FILTER

A sheet of coloured glass, or glass coated with dyed gelatine or collodion, or a cell containing a coloured liquid, used to modify the action of some particular region of the spectrum on the sensitive plate. It is usual to divide colour screens into two classes, (*a*) continuing and (*b*) contrast screens, though the division is purely arbitrary and the two insensibly merge one into the other. The most used form of screen or filter is the yellow screen, which is employed with iso- or orthochromatic plates to reduce the excessive action of the ultra-violet, the violet and blue rays, which it does by partially or wholly absorbing them, and thus, by prolonging the exposure, gives the green and yellow rays more time to act so that the colours may be reproduced more nearly in the order of their respective visual luminosities (*see* "Colour Sensations" and "Luminosity, Visual"). The exact depth of the yellow screen is dependent on the relative sensitiveness of the emulsion to the yellow and blue, and also on the effect desired. For instance, in photographing extremely faint white cirrus clouds against a blue sky the difference in photo-chemical action of the sky and clouds is so slight that a contrast or deep-coloured screen is used abnormally to suppress the action of the sky. On the other hand, when it comes to a pictorial representation of a field of wheat intermingled with poppies, the visual luminosities of which may be approximately equal, the operator's æsthetic feeling or education must teach him to choose either to disregard the truth and to accentuate the golden hue of the wheat at the expense of the scarlet poppy, or else to obtain a compromise between the two. In such a case another factor, of the permissible exposure, comes into play.

Numerous dyes have been used or suggested for making the yellow screen, which has now largely replaced the old form of pot glass orange-colour screen, which contained also a considerable proportion of black that merely increased the exposure by cutting down the available light. Aurantia, auramine, naphthol yellow, methyl orange, tartrazine, and filter yellow K, have all been used. Of these, the last is by far the most effective, as it completely suppresses the ultra-violet rays, which are invisible to us, and has a gradual absorption for the violet and blue. It is a very soluble dye, and is stable to light in the ordinary way.

The following instructions are modifications of those issued by the Hoechst Dyeworks, the makers of this dye, for the manufacture of yellow screens, and they may be considered typical for making all filters, the quantities and dyes merely varying according to the particular requirements.

Stock Dye Solution

Filter yellow K .	31 grs.	2 g.
Distilled water .	14 oz. 38 mins.	400 ccs.

Stock Gelatine Solution

Gelatine (hard emulsion) . . .	420 grs.	60 g.
Distilled water to .	16 oz.	1,000 ccs.

Wash the gelatine by stirring two or three times in distilled water, then drain and add to about three-quarters of the total quantity of water, dissolve in a water bath at 120° F., and if it is to be kept, add a grain of thymol or a few drops of carbolic acid, filter, and make the total bulk up to 16 oz. or 1,000 ccs.

No. 1 Yellow Filter

Stock gelatine solution	2 oz.	120 ccs.
Stock dye solution .	24 mins.	3 ,,
Distilled water . .	168 ,,	21 ,,

No. 2 Yellow Filter

Stock gelatine solution	2 oz.	120 ccs.
Stock dye solution .	48 mins.	6 ,,
Distilled water . .	144 ,,	18 ,,

No. 3 Yellow Filter

Stock gelatine solution	2 oz.	120 ccs.
Stock dye solution .	96 mins.	12 ,,
Distilled water . .	96 ,,	12 ,,

No. 4 Yellow Filter

Stock gelatine solution	2 oz.	120 ccs.
Stock dye solution .	192 mins.	24 ,,

For every 16 sq. in. or 100 sq. cm. of glass allow 122 minims or 7 ccs. of the dyed gelatine, and two of each of the screens must be bound

together. The increase in the exposure with the above filters for pinachrome or erythrosine bathed plates is No. 1 1·3, No. 2 1·7, No. 3 2·0, and No. 4 3·0 times. For commercial iso- or orthochromatic plates—that is, those sensitised in the emulsion before coating—the exposure is about half as much again.

The glass of which the screens are made should be selected patent plate, about $\frac{1}{16}$ in. thick, and it should be as parallel as possible; for the best-quality screens optically worked glass should alone be used. In order to test the glass for parallelism of its sides, it should be placed on a sheet of black velvet and held at an angle of about 45° some distance from the cross-bars of a window, so that the reflection of these can be seen in the glass. On turning the glass round on the velvet, the image of the cross-bars will be seen to be double—that is, the reflection from both the front and back of the glass will be seen. These double images should, as far as possible, be constant in position one to the other, and not shift up and down or from side to side. The glass must be thoroughly cleaned and placed on a thick sheet of plate glass which has been accurately levelled, and the necessary quantity of dyed gelatine poured on to it, coaxed out to the edges with a glass rod, and allowed to set, when it can be put away to dry.

It may be pointed out here that the position of the filter has some effect on the focal length of the lens and also on the definition of the image. When placed behind the lens it slightly lengthens the focus, but its effect on definition is a matter of actual test with every filter, though the nearer the filter is to the plate the less the effect; therefore, obviously, if placed in contact with the sensitive surface, the question of the quality of the glass is not of so much moment, and in this case even fixed-out and washed dry plates may be used.

The cementing of colour screens is a messy process, and requires considerable practice to perform successfully. A fairly thick solution of Canada balsam in xylol, such as is used by microscopists, should be used, and the screens well warmed for at least half an hour, so as to ensure that they are thoroughly dry; the balsam should also be gently warmed. A pool of balsam, about half the size of the plate, should be poured on to one screen somewhat near one edge, and the other screen lowered first on to this edge and slowly allowed to fall down, when it will squeeze the pool of balsam out so as to cover the whole surface. Then a stout bulldog clip should be fastened on each side, and the screens put away in a warm place for the balsam to dry out; this will probably take four or five days. At first it is better to use excess of balsam, as this will be squeezed out and can be easily cut off when dry; but with experience the quantity of balsam may be reduced.

The filters for three-colour work are innumerable, the following being satisfactory :—

Hoechst Dyeworks' subtractive filters for three-colour printing of all kinds.

Blue-violet Stock Solution

Crystal violet .	61·7 grs.	4 g.
Warm distilled water	12 oz. 155 mins.	350 ccs.
Glacial acetic acid .	5–6 mins.	5–6 drops

Filter

Dye solution	338 mins.	20 ccs.
Gelatine solution (6%)	3½ oz.	100 ,,

or—

Stock Solution

Rapid filter blue .	15½ grs.	1 g.
Hot distilled water	6 oz. 160 mins.	180 ccs.
Liquor ammoniæ .	8 mins.	8–10 drops

Filter

Dye solution .	338 mins.	20 ccs.
Gelatine solution .	3½ oz.	100 ,,

This is faster to light than crystal violet.

Green Stock Solution

Rapid filter green I .	62 grs.	4 g.
Distilled water .	3½ oz.	100 ccs.

Filter

Dye solution . .	338 mins.	20 ccs.
Gelatine solution (6%)	3½ oz.	100 ,,

This transmits a narrow band in the extreme red; the following does not, and should always be used with panchromatic plates :—

Stock Solution

Filter blue green .	15½ grs.	1 g.
Rapid filter yellow .	15½ ,,	1 ,,
Distilled water .	3½ oz.	100 ccs.

Filter

Dye solution . .	338 mins.	20 ccs.
Gelatine solution (6%)	3½ oz.	100 ,,

Red Stock Solution

Rapid filter red I .	77 grs.	5 g.
Distilled water .	7 oz.	200 ccs.

Filter

Dye solution . .	338 mins.	20 ccs.
Gelatine solution (6%)	3½ oz.	100 ,,

Allow 118 minims to every 16 sq. in., or 7 ccs. to every 100 qcm., and cement two glasses of each colour together. The ratio of exposures for pinachrome or pinacyanol bathed plates is, for the blue screen (yellow printing) negative, 4; for the green screen (red printing) negative, 8–12; for the red (blue printing) negative, 8–12.

For liquid filters the following, suggested by Newton and Bull, for use with panchromatic plates, with cells of 1 cm. internal thickness :—

Blue Filter

Victoria Blue B (Bayer) (1% sol.) .	448 mins.	47 ccs.
Naphthol green (1% sol.)	174 ,,	18 ,,
Distilled water to .	20 oz.	1,000 ,,

This will not keep well when mixed.

Green Filter

Rapid filter green (1% sol.) . . .	87 mins.	9 ccs.
Naphthol green (1% sol.)	87 ,,	9 ,,
Rapid filter yellow K (1% sol.) . .	87 ,,	9 ,,
Distilled water to .	20 oz.	1,000 ,,

Red Filter

Rose Bengal (1% sol.)	442 mins.	84 ccs.
Rapid filter yellow K (1% sol.) . .	442 ,,	84 ,,
Distilled water to .	20 oz.	1,000 ,,

The above are to be used for the subtractive

process or three-colour printing, whether on paper or in the shape of superimposed stained transparencies for projection. For the projection of transparencies by means of coloured lights or the additive process, the following should be used for obtaining the negatives :—

Violet-blue Stock Solution

Crystal violet	62 grs.	3 g.
Methylene blue	15½ ,,	1 ,,
Distilled water	8 oz. 384 mins.	250 ccs.
Glacial acetic acid	5–6 mins.	5–6 drops

Filter

Dye solution	338 mins.	20 ccs.
Gelatine solution (6 %)	3½ oz.	100 ,,

Green Stock Solution

Rapid filter green 2	62 grs.	4 g.
Distilled water	4 oz. 107 mins.	120 ccs.

Filter

Dye solution	338 mins.	20 ccs.
Gelatine solution	3½ oz.	100 ,,

This transmits a narrow band in the red, but the following does not :—

Stock Solution

Filter blue green	18½ grs.	1·2 g.
Rapid filter yellow	38¼ ,,	2·5 ,,
Distilled water	7 oz.	200 ccs.

Filter

Dye solution	338 mins.	20 ccs.
Gelatine solution	3½ oz.	100 ,,

Stock Red Solution

Rapid filter red 2	77 grs.	5 g.
Distilled water	7 oz.	200 ccs.

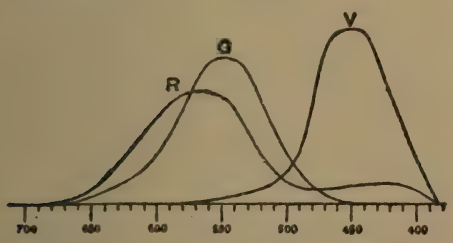
Filter

Dye solution	338 mins.	20 ccs.
Gelatine solution (6 %)	3½ oz.	100 ,,

The quantity of dyed gelatine per area is the same as for the subtractive filters, and two filters of like colour must be cemented together. The ratio of exposures with pinachrome or pinacyanol bathed plates is blue 4, green 12, red 12.

COLOUR SENSATIONS

Although there are considered to be but six or seven spectrum colours—red, orange, yellow, green, blue, indigo, and violet—they melt so insensibly one into the other that there are an



Curves Representing Actions of Various Spectrum Colours

infinite number of distinct colours; again, in natural objects there are innumerable colours. It has been proved, however, that there are only three fundamental colours, that give rise to all the other colours by the excitation of three sets of nerve fibrils in the retina. This theory was enunciated first by Thos. Young (" Lectures on Natural Philosophy," 1807), and further elaborated by Clerk-Maxwell (*Edinburgh Transactions*, 21,275, 1855), Von Helmholtz, Abney, König, and others. The curves representing the respective actions of the various spectrum colours, according to König and Dieterici, are shown in the accompanying diagram, and represent the sensations excited in the retinal nerves by the three fundamental colours. There is some difference in opinion between physicists as to the exact wave lengths of the fundamental colours, but there is not much error in the assumption that they are :—

Red—extreme end of the visible spectrum about λ 665.
Green—λ 507.
Blue—λ 475.

The red sensation curve begins about λ 680, reaches its maximum at λ 575, drops strongly at λ 490, with a slight rise again toward λ 450, and ends at λ 390. The green sensation curve begins at λ 680, rises to a maximum at λ 550, and ends at λ 440. The blue sensation curve rises from λ 580, rises sharply at λ 480 with a maximum at λ 450, and ends at λ 390.

The above may be considered as the now generally accepted theory of the colour sensations, but Hering suggested six fundamental colours—red, green, yellow, blue, white, and black. This theory has not been accepted, but is interesting, as on it has been based a four-colour printing method (Zander).

COLOUR SENSITISING

It was very early recognised that certain colours acted more strongly on the photographic plate than others, and that the former were nearly all those that reflected the violet and blue spectral rays, which therefore were called the " chemically active " or " actinic," whilst green, yellow, orange, and red hardly produced any action at all. This view prevailed for many years, though Herschel pointed out in 1842 that it did not apply generally, as violet petals faded most quickly in green light and the other blue flowers faded most in yellow light. Draper enunciated the law that only those rays acted chemically on a substance which were absorbed by it.

In 1873 H. W. Vogel was examining various silver salts in the spectrograph and found that some English collodion plates, which had been stained with a yellow dye to prevent halation, were distinctly sensitive to green. Led by this fact, Vogel examined the absorptions of various dyes and then added them to collodion emulsion, and found that these also sensitised for the colours they absorbed. This principle was confirmed by others, and soon after was successfully applied to commercial gelatine plates by Attout Tailfer, of Paris.

The action of a very large number of dyes has been examined by various authorities, Eder, Valenta, Von Hübl, Eberhard, Hinterberger, Ruh, etc., and the first-named, who has paid special attention to this subject, has formulated the following important conclusions: (1) The absorption spectrum of neither an alcoholic nor

of an aqueous solution of the dye coincides with the position of maximum light action on the dyed gelatino-bromide of silver. (2) The maximum of sensitiveness of the dyed silver bromide lies nearer the red than does the absorption maximum of any solution. (3) The position of the maximum of absorption of the dye in gelatine and that of the maximum of sensitiveness of the dyed silver bromide differ generally by about thirty wave lengths; that is to say, those rays of light that are most active photographically on the dyed silver bromide possess a mean greater wave length of about thirty wave lengths than those that are absorbed by the dyed gelatine (without the silver bromide). (4) The absorption maximum of silver bromide dyed with eosine coincides exactly with the maximum of light sensitiveness on silver bromide dyed with eosine; that is to say, those light rays which are absorbed by eosine-dyed silver bromide have the same wave length as those for which the dyed silver bromide shows the increased sensitiveness. (5) The dyes must stain the silver bromide grain; the dyes that act vigorously are all "substantive" dyes. (6) They must show in the dry state—on dyed gelatine, or more correctly, on dyed silver bromide—even in considerable dilution, an intense absorption band if they are to produce an intense action on the silver bromide. A narrow absorption band gives a narrow sensitising band.

Although it has been established that a colour sensitiser must dye the silver bromide grain, yet all dyes that stain the silver bromide are not sensitisers. Neither fluorescence nor fugitiveness to light plays any important part, as pure erythrosine is not fluorescent and yet is a powerful sensitiser, and is fairly stable to light, whilst cyanine is very unstable and is a good sensitiser. Apparently, there is no connection between the chemical constitution of a dye and its sensitising powers, though Lumière and Seyewetz have concluded that the sensitising action is connected in some way with the chromophoric group of elements. Joly has pointed out that all the sensitisers are photo-electric, and assumes that electrons are set free from the dye which act on the silver halides.

Colour sensitive plates may be divided into practically two main classes, the commercial isochromatic or orthochromatic plate and the panchromatic plate. The former are usually prepared by adding erythrosine to the emulsion, either at the time of mixing or just before coating, and are sensitive mainly to yellow-green and yellow, there being a characteristic gap or lack of sensitiveness in the blue-green. The panchromatic plates are nearly all made by bathing the finished and dried plates in a solution of the erythrosine.

The method of introducing the dye into the emulsion has considerable influence on the resulting colour sensitiveness. Those dyed in the emulsion—that is, before coating—have usually a lower χ than plates bathed in a dye solution; that is, they are less colour sensitive, though the reason for this is not apparent.

Although excellent commercial colour-sensitive plates can be obtained, the following information may be useful. To sensitise for blue-green and green, up to about λ 5,500, the best dye is acridine orange NO, of the Leonhardt Farbwerke, Mühlheim.

Stock Solution

Acridine orange NO .	9·6 grs.	1 g.
Alcohol . . .	20 oz.	1,000 ccs.

Industrial alcohol may be used instead of the pure. The actual sensitising bath is:—

Stock dye solution .	4 oz.	200 ccs.
Distilled water to .	20 ,,	1,000 ,,

For greenish-yellow and yellow up to λ 5,900, erythrosine should be used, and the most suitable dyes are bluish erythrosine of the Badische Anilin and Soda Fabrik, that made by Schuchardt, of Görlitz, or the pure dye of Meister, Lucius and Brüning, of Hoechst. A stock solution is made of 1 : 1000 of alcohol, as with acridine; the sensitising bath is:—

Stock dye solution .	4 oz.	200 ccs.
Liq. ammoniæ (·880) .	96 mins.	10 ,,
Distilled water to .	20 oz.	1,000 ,,

Erythrosine is an excellent sensitiser for the above region, but it leaves a minimum or gap in the bluish green, which, however, fills up with a generous exposure, so that it can be used instead of acridine orange for all but spectrum work in the blue-green, and has the advantage of being more readily washed out of the gelatine, alcohol alone being able to remove the last traces of acridine.

To sensitise for green, yellow, and red up to about λ 6,200—λ 6,400, one of the following should be used: orthochrome T, pinaverdol, pinachrome, or homocol, the action as red sensitisers being greater in the last two than the first two. A 1 : 1000 alcoholic stock solution should be made, which should be kept in the dark; the actual sensitiser is—

Stock dye solution .	20 mins.	2 ccs.
Distilled water .	20 oz.	1,000 ,,

For the extreme visible red pinacyanol should be used in the same way.

For the infra-red, about wave length λ 7,180, "little a," as it is usually called, dicyanine should be used as above, only the stock solution must be added to the water at the very last moment, when everything is quite ready, and the plate immediately flowed with the dye, as the weak solution loses its sensitising power very quickly.

The most convenient method of sensitising is by means of a grooved trough, into which, when filled with dye solution, the plates can be dropped. Or the worker may use a dish twice as large as the plates to be sensitised at one time. These are put at one end of the dish; the dish is tilted, and the dye solution poured into the empty end; then the dish is tilted back, so that the dye solution runs in an even wave over the plates. The dish should be gently rocked for three minutes, then the plates removed and washed in a good stream of running water for three minutes, and set up to dry in a proper drying cupboard, or in an air-tight box containing a saucerful of calcium chloride.

An alternative method of sensitising which considerably hastens the drying, is to replace two-fifths of the water in the above baths by

acetone or methyl alcohol; the plates then dry in about half an hour in a warm place.

The best panchromatic sensitiser is that suggested by R. J. Wallace.

Pinacyanol (1 : 1,000 sol.)	134 mins.	14 ccs.
Pinaverdol (1 : 1,000 sol.)	106 ,,	11 ,,
Homocol (1 : 1,000 sol.)	106 ,,	11 ,,
Liquor ammoniæ . .	318 ,,	33 ,,
Alcohol . . .	8 oz.	400 ,,
Distilled water to .	20 ,,	1,000 ,,

The plate to be sensitised should be clean working and with a fine grain, and therefore not too rapid. Care must be exercised as to the darkroom illumination and no light should be used for red sensitising. E. J. W.

COLOUR SENSITIVENESS

Silver bromide precipitated in the form of an emulsion possesses great sensitiveness for the ultra-violet, the violet, and blue spectral regions. With an admixture of iodide of silver, precipitated at the same time, the sensitiveness extends beyond the bright blue slightly into the bluish green, but there is no practical sensitiveness to green, yellow, orange, or red. Sensitiveness to these regions is conferred on the silver halides by the addition of certain dyes to the emulsion in the making, or preferably by bathing the dry plates in aqueous solutions of dyes. It will be noted that the expression "no practical sensitiveness" is used, and this is employed for the specific reason that if the exposure is sufficiently prolonged, all the spectral colours will affect the silver halides, but the more actinic rays must be screened off by suitable filters; it is not practical to give such prolonged exposures in the process.

COLOUR SENSITOMETER

A series of coloured glasses or dyed gelatines having special spectral transmissions, used for testing the colour sensitiveness of plates. Vidal constructed one of the first of these instruments, and the Chapman-Jones plate tester can also be used for the same purpose. Abney has suggested a somewhat similar instrument. They have not found extended practical application. (*See* "Colour Sensitometry.")

COLOUR SENSITOMETRY

Soon after the introduction of the colour sensitive plate some method was found needful for expressing the added colour sensitiveness, and this was effected by exposing a plate in the spectrograph and estimating the densities by visual examination or merely drawing a graphic curve, a test of great unreliability, still further complicated by the fact that prismatic spectrographs were used. Later, plates were exposed to isolated patches of monochromatic light, a curve being obtained from the resulting negatives. This method was still further improved by using a spectrum and varying intensities of white light and obtaining an interpolation curve.

The great disadvantage of the spectrographic method is that it is not capable of brief and commonly understood expression, and therefore many attempts have been made to obtain sensitometric tests by means of charts of coloured pigments, which are open to the most serious objection that the pigmentary colours reflect an enormous amount of white light, and whilst there is no object in nature that does not reflect white light, what the worker really desires to measure is the true increase in sensitiveness to a pure colour. Abney's colour sensitometer and the Chapman-Jones plate tester consist of coloured glasses or gelatines of equal luminosity, transmitting either small or broad isolated patches of the spectrum, and the densities obtainable can then be read and charted. Later, Eder and others divided the spectrum into three broad regions, the one including the blue and violet up to about λ 5,000, which is practically the sensitiveness of the ordinary emulsion; a second region extending from the blue through the green to the yellow up to λ 5,900; and a third, used only for panchromatic plates, extending through the red. Eder utilised the Scheiner sensitometer, and thus expressed numerically the actual ratio of speeds of the non-colour-sensitised emulsion and the added colour sensitiveness.

This method has been still further extended by Mees and Sheppard to the Hurter and Driffield system, and is the most practical. The following are briefly the main features of it: the H. & D. sector wheel and the screened acetylene light (*see* "Plate Testing") are used, and between the light source and the sector wheel are inserted absorbent solutions which limit the active light to particular regions of the spectrum. For testing commercial iso- or orthochromatic plates, a yellow and a blue filter (Eder) are used; the yellow filter consists of a 4 per cent. solution of potassium chromate (not bichromate) in a thickness of 1 cm. The blue filter is a 2 per cent. solution of ammonio-sulphate of copper, also in 1 cm. thickness. The plate to be tested is exposed behind these two filters, and after development the inertias are found in the usual way, and the result or ratio termed χ (*chrōma*, a colour), and is—

$$\frac{\text{yellow inertia}}{\text{blue inertia}} = \frac{\text{blue sensitiveness}}{\text{yellow sensitiveness}}:$$

For instance, a commercial iso plate was found to have an inertia of 0·34 behind the blue screen and an inertia of 4·8 behind the yellow screen; then—

$$\frac{\text{yellow inertia } 4{\cdot}8}{\text{blue inertia } 0{\cdot}34} = \frac{\text{blue sensitiveness } 100}{\text{yellow sensitiveness } 7{\cdot}1} = \chi\ 14.$$

For panchromatic plates, it is essential to know also the increased sensitiveness to red; and Mees and Sheppard use three screens as follows: the blue screen is Eder's given above, which passes the violet and blue up to λ 5,000; the green screen, which passes from λ 5,900 to λ 5,000, consists of Eder's chromate screen given above plus a screen of 1 cm. thickness of a saturated solution of copper acetate; the red screen is made with rose Bengal and tartrazine:—

Rose Bengal . .	48 grs.	5 g.
Tartrazine . .	96 ,,	10 ,,
Distilled water to .	20 oz.	1,000 ccs.
Gelatine . .	728 grs.	73 g.

Allow 20 minims, or 1·25 ccs., to every square inch of glass.

In all cases the screened acetylene light has been used, and whilst this does not give the absolute inertias of the plate, the ratios of colour sensitiveness are preserved. For three-colour work the actual filters to be employed may be used in the same way, and if an exposure be made without a filter the necessary increase of exposure for the blue-violet filter over the unscreened plate can readily be found. Considerable influence is exercised naturally upon the results obtained by the nature of the light employed, and one can easily understand that the standard light should be, if possible, daylight of constant spectral composition, or a secondary standard with as near as possible the same spectral composition; for if the light be yellow, with a decided paucity in violet and blue rays, and corresponding richness in yellow and orange, the colour sensitive plate would show a much higher colour sensitiveness, which would be totally misleading. E. J. W.

COLOUR TEST FOR PLATES (*See* "Plate Testing.")

COLOURING PHOTOGRAPHS, ETC.

The three popular processes for colouring prints and slides are by means of aniline dyes, water colours, and oil colours. Colouring by the crystoleum process (*which see*) is also widely practised. Aniline dyes, although not so permanent as water colours, have largely superseded the latter, the dyes being so cheap and easy to use; they are also transparent, and allow the details in the pictures to show through them, whereas some water and oil colours are body colours which hide all detail.

Photographs to be coloured with dyes or transparent pigments should not be deeply printed or given too warm a tone; but these points are of no importance when body colours are used. A desk of some kind, or an easel, will be required for large prints, but small ones may be laid flat upon a table or held in the hand. Lantern slides and other transparencies are best held in the hand over white paper, or placed upon a retouching desk in such a way that the light comes through the slide, using preferably artificial light, as slides coloured in daylight are sometimes disappointing when viewed on the screen; transmitted light allows the density of the colours to be better judged. Sable brushes of the sizes known as No. 0 (very small) to Nos. 5 or 6 will be found the most serviceable for average work, but others, as experience dictates, may be found useful.

Aniline Dyes.—These are the simplest of all colours in use, and may be used for slides and all kinds of prints, although they appear to best advantage on ordinary P.O.P. (gelatine) prints. Suitable dye solutions all ready for use may be purchased, the colours being put up in cheap sets and in very convenient form. Penny packets of dyes, obtainable at oil shops, are good enough for experimental work; to prepare them for use dissolve first in ½ oz. of acetic acid or vinegar and make up to 2 oz. with water. The raw dyes may be dissolved and prepared in the same way, but very little of the actual dye need be used, as they are very strong, and a few grains will make a large quantity of coloured solution. The number of colours will depend upon the character of the work; clever colourists, it should be said, can get all the colours they want by using only three—blue, yellow, and red—as by mixing these in suitable proportions any colour likely to be needed can be produced; blue and yellow make green; red and yellow, orange; blue and red, violet, etc. etc., the exact tints depending upon the proportions of the two colours. The average worker will prefer ready-made dye solutions, and the following will be found the most serviceable: Blue, yellow, brown, olive green, scarlet, purple, orange, and pink. These dyes may be combined if desired, green and orange, for example, making citrine; orange and purple, russet; etc. The secret of success in using aniline dyes is to have them weak, building up the colours required by repeated washes of the dye rather than attempting to obtain in one application a colour of full strength. So important is this that the beginner is advised to begin colouring with dyes near to a water tap, so that as the colours are put on they may be largely washed off under the tap, the operations being repeated until the desired strength is obtained. The process is really that of staining or dyeing the print rather than painting, as the last-mentioned term is generally understood. If the print is mounted and cannot be satisfactorily rinsed in water, the colours should be applied to the print very dilute, and immediately blotted with clean white blotting-paper. This prevents the dyes acting too quickly, and obliges the worker to proceed slowly and build up the colour. Blotting-paper is not suitable for use on slides, and the slides should be repeatedly rinsed instead, unless the dyes are applied sufficiently weak in the first instance. Prints do not usually require any preparation for colouring, but if much blotting or rinsing is to be done or the brush is at all stiff, it is advisable to harden gelatine films—P.O.P., bromide and gaslight papers and lantern slides—with a solution of 1 oz. of formaline in 10 oz. of water; the fixed and washed slide or print is immersed in this for about ten minutes and then washed well. Alum should not be used for hardening previous to colouring with dyes, as it is apt to react chemically with some of the colours.

Water Colours.—Water colours may be employed for all kinds of prints and slides. They differ essentially from dyes in that they do not sink into and stain the film, and therefore the surfaces need to be specially prepared so that they do not repel the colours; also, a medium is necessary for the colours in order that they may not dry dull and dead. A suitable application for prints is the following oxgall mixture:—

Purified oxgall . .	15 grs.	6 g.
Methylated spirit . .	1 oz.	250 ccs.
Distilled water . .	4 „	750 „

This should be well mixed and applied to the surface with a broad, soft brush, and the print when dry will be in a proper state to take both water colours and even oil colours. This preparation is essential for albumen prints and others with a greasy surface, but may be omitted in the case of freshly-made P.O.P. or other gelatine prints.

A suitable medium to use in place of water

for the water colours is made by dissolving a small quantity of the best gum arabic in sufficient water to cover it, and adding two or three drops of glycerine. This is not necessary for matt surface prints. An albumen solution must be used as a medium when colouring albumen prints, and some workers use it for all kinds of glossy prints; it takes the place of the gum mixture, and is quite as good. The albumen mixture consists of the following:—

White of egg . .	1 oz.	30 ccs.
Glycerine . .	15 drops	15 drops
Liquor ammoniæ .	15 „	15 „
Ammonium carbonate	20 grs.	13 g.
Water . . .	2 drms.	7 ccs.

Whip the white of egg to a froth, allow to stand until clear, add the other chemicals previously dissolved in the water, and filter through muslin.

The choice of water colours is an important item; there is a feeling in favour of colours in pans and not in tubes, but there is probably not much in the preference. Some are transparent, others semi-transparent, and others, again, are opaque or body colours. An experienced worker may use any or all for print colouring, but for lantern slides transparent colours must be used. They are easily recognised by painting a few dabs upon glass and examining by transmitted light. Transparent colours are Prussian blue, crimson, alizarine yellow, Italian pink (which is really a yellow), olive green, sap green, purple madder and lake, and burnt carmine. The opaque colours are light red, yellow ochre, scarlet lake, ultramarine, Naples yellow, burnt umber, and Vandyke brown. The semi-transparent colours are sepia, madder brown, raw and burnt sienna, cobalt, and bistre. The above list is not by any means complete, but contains enough for average work. When white is required, Chinese white and no other should be used. For faces of portraits the colouring is usually put on very weak in the form of cross hatching, but for all other work colours are brushed on in the usual way, using plenty of the medium so as to weaken the colours.

Lantern slides can be coloured with transparent water colours, but they need no special preparation, although many consider it advisable to harden them with formaline. Colours are applied in broad, even sweeps, and but little difficulty will be experienced except in skies, which more often than not are plain glass. When the Prussian blue—really the only pigment available for the purpose—is put on the plain film, brush marks are likely to show, but this defect is remedied by dabbing the blue while wet very gently with the finger-tip, or with a piece of kid glove stretched over the finger. The sky may be stained an even blue with dyes, and then given character with water colours. The slides also may be chemically toned to various tints and then completed with water colours. Considerable practice is necessary for lantern-slide work, and no small artistic skill, if it is wished to avoid the banal effects frequently seen in commercial slides.

Oil Colours.—Painting in oils, particularly upon enlargements, is chiefly a professional practice, and the method of doing the work depends to some extent upon the materials used. Transparent oil colours may be handled in a different manner from that adopted when body (opaque) pigments are used. The latter cover up the image, whereas the former, which give a rather weak effect, permit the shades and details of the picture to show through. For strength and high colouring the opaque colours are necessary, and for their use a knowledge of drawing and painting in general is requisite, as the photographic image is simply used as a base. The colours which will be found of the greatest service are emerald green, Vandyke brown, indigo, Indian red, burnt umber, pink madder, light red, raw sienna, Naples yellow, yellow ochre, burnt sienna, crimson lake, raw umber, ultramarine, flake white, and ivory black.

Any kind of print may be coloured in oils—bromide paper being the most widely used—but owing to the oily nature of the colours it is necessary to size the print first in order to prevent the colours sinking into the paper. To make a suitable size, dissolve one pennyworth of clear patent size (obtainable at an oil-shop) in one pint of hot water, and when nearly cool give the picture a coat, and set aside to dry in a warm place. The coat of size must not be too thick, or it may peel off at a later stage and bring the colours with it. The brushes should be varied both in kind and size, according to the work. There should be provided stout hog-hair brushes, some thin badger brushes, and a few small sables; a badger softener is also useful. Megilp is used for thinning the colours, and a plentiful supply of turpentine should be provided for washing the brushes.

The methods of applying the actual colours vary considerably. It is usual to apply a suitable tint to the deepest shadows, and to work from this to the highest lights, using a more solid colour as the work proceeds, the reverse of water-colour painting. Drapery and costumes in portrait work may first be covered with transparent colour, working into it the various tints for the shadows, half-tones, and high lights. After the first tints have been put in, it is usual to let the canvas dry and to rub over with poppy oil, removing the excess with chamois leather; the more delicate colouring is then worked in. It is difficult to give precise instructions for colouring, and the worker must to a large extent be guided by his own tastes. When the painting is completed it should stand on one side for a month before varnishing with copal or mastic, and in no case must the varnish be applied until the painting is dry. Copal is a hard and durable varnish, but mastic is widely used because it dries quicker and, if necessary, may be removed easily.

For lantern slides transparent oil colours must be used. They are sometimes put on with a brush in the same way as water colours, but it is more general to dab on the colouring with the finger-tip. The best way of obliterating the grain of the finger-tip is to work upon the slide placed at different angles so as to cross the markings and break them up very lightly into a series of small dots. The finer details are best coloured by means of a fine sable brush, but too much colour must not be put on, as it is better to under-paint than over-paint, it being easier to add the colour than it is to take

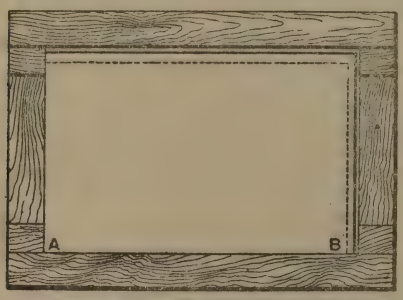
it away. A useful dodge is to put the oil colours at first on the plain glass side, from which they may easily be removed if any error is made, or the colouring may be put on the cover glass of the slide. Parts of the slide may be coloured with dyes and parts with oil and water colours with good effect, but, no matter what process of colouring is adopted, some practice is necessary, particularly with oils, which are the most difficult for a beginner to use satisfactorily. A slide for colouring in oil or water colours must be lighter and brighter than those for ordinary use, and it is important that they be dried in a room free from dust, as any specks or hairs upon the slide will show up very prominently when magnified upon the screen. P. R. S.

COMA (Fr., *Aberration zonale;* Ger., *Zonen abirrung, Nebeliger saum*)

Synonyms: oblique spherical aberration, zonal aberration. A defect resulting from the unequal magnification of the different zones of a lens, these zones being defined as imaginary circles dividing the surface of the lens into concentric rings. As a result of coma the image of a bright point of light towards the margin of the field of view, produced by oblique rays, will be rendered as a comma- or pear-shaped blur—whence the name "Coma." Coma may occur in a lens otherwise well corrected for chromatic and spherical aberration, and is approximately removed by careful design of the curves of the objective and precise selection of the different kinds of glass.

COMBINATION PRINTING

The art of making a print by the use of two or more negatives. The simplest form of combination printing is the printing of a cloud into a landscape, but combination printing proper is the art of adding trees, figures, or other objects to a picture, as practised by Rejlander, Robinson, and other past masters of the art. Combination printing had its origin in 1855, when Berwick and Annan, of Glasgow, exhibited a



Arrangement for Combination Printing

picture printed from two different negatives—a figure in a landscape. In 1858 Sarony patented an improved process which consisted of taking up the different portions of the collodion film from the glass of one or more negatives and laying them down upon another glass in their proper relative positions and printing from it. Rejlander, however, was the first to draw attention to the possibilities of combination printing, and in 1857 he used thirty negatives to produce a single picture ("The Two Ways of Life"), which he exhibited at the Manchester Exhibition of that year; all except the part required was blocked out on each negative, all the negatives were then laid in turn upon sensitive paper and printed, the remainder of the paper being covered with black velvet. In the following year (1858) Robinson produced the first of his famous series of combination prints, "Fading Away," for which five negatives were used, and in 1863 "Bringing Home the May" (nine negatives); this type of combination printing then became the craze.

The methods fully described under "Clouds, Printing in," may be adopted in some forms of combination printing; but in others, such as the addition of a figure to a landscape, or the substitution of a suitable background for an unsuitable in a figure subject, a different method will be more fitting (*see*, for example, "Backgrounds, Printing in"). In many cases, however, the pencil and brush marks described under the heading first given above will be found useful in securing registration.

For combining portions of two or more negatives to form one print, whether the object is to print a new background to a figure or to combine in one picture selected parts of two or three landscapes, etc., the method described under the heading, "Backgrounds, Printing in," or some modification of it, can be adopted. In some respects the method about to be described has points of advantage compared with that given at the reference last mentioned. A silver print is taken from the figure negative, and the figure cut out very carefully with a sharp knife. Both parts of the print must be kept to form masks. First, the portion from which the figure was cut should be attached to the glass side of the figure negative, and then the two negatives should be held together vertically with their edges resting on the table and the corners accurately coinciding, or preferably placed on a retouching desk with their corners together. The figure negative must be underneath and the glass side of each negative towards the worker. The figure that was cut from the rough print must now be attached to the glass side of the background negative in such a manner that it corresponds in position accurately with the opening in the mask on the figure negative, this opening being easily seen for obtaining a correct adjustment by this method of holding the two plates.

In printing, it is immaterial which negative is used first. Either negative is placed in the printing frame with one edge in close contact with the woodwork of the frame—preferably the edge that was resting on the table when the masks were adjusted on the negatives. In the diagram the edge A B is shown pressed closely against the frame, the corner being pressed right into that of the frame. The printing paper need not be cut accurately to fit the negative, but it must touch the same side and the same corner of the frame as the negative. The paper is indicated by dotted lines. When this part of the printing is finished, the print and the negative are removed from the frame, and the second negative is placed in the frame with its corresponding side and corner pressed closely against the side and corner A B. The print is again

placed in position as before with the same side and corner touching the same parts of the frame, and the second part of the printing completed.

If the masks have both been accurately fitted to their respective negatives, the two parts of the print should join perfectly. Each print will show a soft outline due to the fact that the blocking out is on the glass side of the negative, and these two outlines will slightly overlap and soften into each other in such a manner that, with reasonable care in fitting the masks and in printing, the junction will not show. When the blocking out is on the film of the negative it is almost impossible to prevent the junction from showing as a hard and crude line, white in some places, dark in others. Masking on the glass side possesses the great advantage that it does not spoil the negative for other purposes. At any time the masking may be removed, leaving the negative uninjured.

COMBINED DEVELOPMENT AND FIXING (*See* "Development and Fixing Combined.")

COMBINED LENSES

When two lenses, such as the Zeiss single anastigmats, are combined to form a doublet, there is a simple formula for finding the focal length of the combination. It is to divide the product of the focal lengths of the two components by their sum minus the distance by which their optical centres or nodes of emission are separated. Thus, in the case of two lenses with focal lengths of 7 in. and 11 in. respectively, with a separation of 2 in., the focal length is arrived at as follows:

$$\frac{7 \times 11}{7 + 11 - 2} = \frac{77}{16} = 4\tfrac{13}{16} \text{ in.}$$

If a positive and negative lens are combined, the focus of the negative lens is taken as a minus quantity, the calculation being otherwise the same.

It is often necessary to find the focal length of a lens which when added to another of known focus shall produce a given focal length. Thus, a single lens having a focal length of 18 in. is to be used with another so that the focal length is reduced to 12 in. The rule is to multiply the focus of the lens of known focus by the focus desired, and to divide the product by the known focus less the desired focus. Taking the above example, the working is:—

$$\frac{18 \times 12}{18 - 12} = \frac{216}{6} = 36 \text{ in.}$$

No account of the separation has here been taken, but if absolute accuracy is desired with, say, a separation of 2 in., the formula is:—

$$\frac{(18 \times 12) - 2}{18 - 12} = \frac{214}{6} = 35\tfrac{2}{3} \text{ in}$$

(*See also* "Magnifier.")

COMBINED REDUCERS (*See* "Reducers, Combined")

COMBINED TONING AND FIXING (*See* "Toning and Fixing, Combined.")

COMETS, PHOTOGRAPHING

The first attempt to portray the form of a comet was in the case of Donati's comet of 1858, but the results were very imperfect, owing to the photographic processes being then in their infancy. The first useful photographic cometary records are of Tebbutt's comet of 1881. The gelatine dry plate had been introduced, and with its increased rapidity, compared with the old collodion plates, the problem was much less formidable. Further improvements were made by the employment of large-aperture telescopes, chiefly of the reflector class. Inasmuch as the comet is generally moving very rapidly in a special orbit of its own, irrespective of the earth's direction of rotation, the usual equatorial telescope is of little use unless special arrangements are made. To obviate the difficulty various schemes have been devised. The most successful, and the only one we need mention in a practical treatise, is that employed by Prof. E. E. Barnard, of the Yerkes Observatory, near Chicago. He first makes a preliminary observation to determine the rate of motion of the cometary nucleus, and its direction as projected on the sky. Then, attached to the eyepiece of his telescope, with which he follows the comet nucleus during exposure of the plate, he provides a fine spider thread fixed on a movable frame actuated by a delicate micrometer screw. If, now, he knows how far the comet will move on the ground glass of his camera in, say, a second, he has only to move this adjustable cross-wire, set in the direction of the comet's motion, by the same amount, and then by keeping the comet nucleus continually bisected by the cross-wires, its image will of necessity be kept exactly on the same portion of the photographic plate. It is a similar problem, but somewhat more delicate, to that of taking a series of photographs of a moving object with a kinematograph camera: the whole apparatus is usually traversed by means of a screw-and-worm gear.

For recording the whole phenomena attending the passage of a comet, probably the most useful instrument is a wide-angle camera attached to a perfectly rigid form of equatorial mounting. Needless to say, the better the lens that is available the better will be the resulting photographs. The modern wide-angle anastigmat is the ideal instrument, and as in these cases it is an object of definite area that has to be portrayed, the greater the ratio of aperture to focal length the shorter will be the time of exposure necessary to obtain a satisfactory image, and in consequence the risks of failure due to vibration or bad weather will be minimised in proportion.

The plates used should certainly be backed and panchromatic, as a considerable proportion of the cometary light is green and yellowish-green, and this is all ineffective if ordinary plates, sensitive only to the blue and violet, are employed.

Development should be very carefully performed, as in general the range of gradation will be very great, varying from the intensely brilliant nucleus to the filmy streamers constituting the delicate tail. The developer may be pyro soda, rodinal, metol, or metol-hydroquinone, but the developers giving excessive density without the full scale of detail should be avoided.

COMPASS, PHOTOGRAPHER'S (Fr., *Boussole horaire;* Ger., *Photographischer Kompass*)

A magnetic compass the dial of which is arranged to indicate the time of day when the subject, in any given direction, will be most favourably lighted for photography.

COMPENSATING EYEPIECE (*See* "Eyepieces.")

COMPENSATION FILTER

A screen (generally yellow) for cutting off excess of ultra-violet, blue, and violet rays (*see also* "Colour Screen or Filter"). In process work it is used largely in colour work, especially with collodion emulsion, it obviating excessive staining of the emulsion in cases where the latter is stained by the addition of a dye.

"COMPENSATOR" NEGATIVES

A system advocated by Newton Gibson and published in April, 1905, for preventing halation without backing and controlling contrasts when taking difficult subjects, particularly interiors. The method is to place a dry plate, glass side towards the lens, in the camera and to give a very short exposure in order to secure the high-lights and not the shadows; the plate is then developed, fixed, and dried. When quite dry the under-exposed negative is placed in the dark-slide in contact (film to film) with another dry plate, and the same view taken again through the compensator negative, taking care to give a full exposure for the shadows. If the first negative is of the right density, the second will develop in good gradation, the windows and other high-lights not being over-exposed and too dense, because of their being covered by the compensator through which the light has to pass to act on the second plate. Obviously the camera must not be moved in the slightest degree between the two exposures, or the picture will not be in register; and the system is therefore out of the question where the camera cannot be left untouched for some time. Success depends mainly upon the accuracy of register, and the relative amount of exposure and development necessary for the compensator negative and for the final negative. It is possible to over-correct the highest lights by making them so dense on the first negative that light will not go through them.

The process can be adapted to existing faulty negatives. A thin positive is made by contact on celluloid film, and when developed and dry it is bound or cemented to the negative in the position occupied when printing. The thickness of the celluloid film between the negative image and the sensitive paper when printing will cause no trouble if a fairly concentrated light, entirely from the front and not from the sides of the frame, is used for printing.

COMPOSITE, ANALYTICAL, OR "AVERAGE" PORTRAITS

A style of picture made by taking several portraits of the same size upon one plate, or by printing from several portrait negatives upon one piece of paper, the result being supposed to give a type of the whole. Such pictures are claimed by some to be of scientific value to students of anthropology, but they are more generally looked upon as curiosities. About the year 1887 they were popular in the United States. Their origin is said to be due to a conversation between Herbert Spencer and Francis Galton about the year 1876, and Darwin also had some correspondence on the subject in 1877. The original idea was to have heads of two different people, one upon each half of a stereoscopic picture, and to combine the two in a stereoscope, which method serves admirably; but not more than two different heads can be combined in this way, whereas by taking negatives specially for the work any number of faint images of several portraits in succession can be obtained on one plate, finally developing the whole as one portrait. If reasonable care is taken in the making of such a composite negative there is seldom anything about the composite picture to indicate that it is not a mere portrait of an individual, whereas, of course, it is a combination of the portraits of several. Full or three-quarter faces make the best composites, and before beginning the work the focusing screen should be marked where the eyes, nose, and mouth are to be upon the screen, the markings being made when the first sitter is posed and focused. The images of the sitters which follow must be adjusted to those lines; and as there is a variation in the distances between eyes, nose, and mouth, the camera has to be adjusted after each partial exposure. The total time of exposure must be divided up between the number of sitters. If, for example, the time required for an ordinary portrait is three seconds, and it is required to make a composite portrait of three sitters, the exposure in each case will be one second. When the number of sitters is relatively great, the lens must be stopped down to allow of increased exposure being given. For example, in making a composite portrait of six sitters, it would be better to use such a small stop that the exposure would be increased to, say, twelve seconds, when each sitter would be given two seconds. The lighting should be the same throughout, and it is also advisable to have a dark covering over the shoulders and round the neck, instead of white collars, fancy ties, blouses, etc., so as to obtain a uniform effect.

An inferior method is to copy a series of portrait prints upon one plate so as to get one negative of the whole; and another is to make transparencies from several portrait negatives (if they match properly) and make one negative from them by contact or through the camera, printing or copying each in turn so as to get a negative of the whole, by a series of partial exposures.

Probably the most famous of all composite portraits was that produced by Oliver Lippincott, of New York; it included portraits of fifty-one bank managers, and took from December 10, 1908, to July 27, 1909, to complete. All were taken full face, and all eyes and pupils were registered, irrespective of the size of the head. Positives were made from the original negatives—all of which were taken separately—by means of prismatic reflectors and a twelve-power magnifying glass, and registered accurately

upon the screen. Every fourth positive was again converted into a negative, and every fourth negative again into a positive, the process being repeated until the final negative was arrived at, and the whole of the fifty-one individuals converted into one portrait. Lippincott states that it took 783 negatives and positives to accomplish the work, and, deducting failures, it took 553 positives and negatives to complete the one picture, which was widely published under the title of "The King of Finance."

Composite prints of a sort may be made from existing portrait negatives if they happen to match in posing, lighting, and size. P.O.P. is used and the first negative partly printed, the remaining negatives being then printed in turn upon the one piece of paper, and the print finished in the usual way.

There is a kind of composite photography (not portraiture) frequently employed in the production of picture postcards. Figures are cut out from different prints, stuck upon the same base, and copied, in this way obtaining many curious but worthless, inartistic, and untruthful effects.

COMPOSITION, PICTORIAL

Composition is the placing or arrangement of the different component parts of a picture in such a manner that the result is pleasing and harmonious. Much has been said and written about the so-called "laws" of composition. The use of the term "laws" is hardly justifiable. Even the most definite and emphatic rules may be broken with impunity, frequently to the advantage of the result. The most that can fairly be said is that some arrangements are found to be more pleasing than others in the impression they create. By studying the elements of these more pleasing arrangements certain generalities are deduced, but these should not be dignified by the name of laws.

It is safe to say that the best pictorial work is not the result of a rigorous application of some clearly defined code of "laws." It is rather the outcome of a kind of instinct, a natural feeling for what is harmonious, tasteful, and pleasing. Whether that instinct can be created is very doubtful; but it can certainly be fostered and cultivated by careful study of Nature, and of graphic representations of Nature produced by others who have themselves studied and observed. Thus will be produced a perception or sense that certain things are "right" and that others are "wrong"; and efforts can then be made to secure the right and avoid the wrong.

The natural limitations of photography impose severe restrictions on the worker in his attempts to secure what he considers to be good composition. Apart from combination printing and certain limited means of modification, he is almost confined to selection of subject and point of view to secure the result he desires. He should by all means familiarise himself with any available expedients that may assist him to reach the desired goal, but to a great extent he will have to content himself with what is before him rather than what he would wish.

Nevertheless, it may be helpful to give a few examples of what is, in a general way, to be sought for or avoided. A picture should contain one principal object, or group of objects, which should not be placed too far from the middle of the space. Everything else should be complementary and subordinate to this. Two or more objects of equal importance will distract the attention and produce a lack of unity. The eye should be led or attracted to the principal object—there should be nothing that forms a kind of barrier. There should be no strong patches of light, or anything else that irresistibly attracts the eye, at the edges of the picture. Neither should lines lead out of the picture or to the unimportant parts of it. Detached patches, either of light or shade, should not be scattered about over the space. The horizon line should not bisect the picture, neither should the space be divided into halves diagonally. One mass may advantageously be repeated by another similar but subordinate. Upright lines may be contrasted with, and broken by, horizontal ones; and a line leading in one direction may be balanced by one running in the opposite direction. Balance, however, should not be too symmetrical and formal. An arrangement of masses that forms a rough triangle with the apex towards the top of the picture is generally effective; as is also one in which the main lines radiate from the principal object.

Such general suggestions as these might be extended to great length. But no multiplication of them, or knowledge of them, will of itself be sufficient to ensure the production of pictures of satisfactory composition. Patient and careful study and analysis of pictures of acknowledged merit will be found interesting and helpful. It will aid in forming ideas as to the means by which certain satisfactory results may be obtained, and will strengthen those faculties of judgment and good taste without which the most elaborate series of rules of composition will be of no avail. (*See also* "Lines in Composition.")

COMPOUND LENS

An almost obsolete term used to denote the difference between the single or landscape lens and the double or triple combinations composed of more than one cemented element.

COMPRESSED CHEMICALS

For convenience of carriage when touring, many photographic chemicals are now obtainable either compressed into small glass or card packages or in the still more portable form of tablets, "tabloids," "scaloids," etc. The advantage of this method of packing chemicals, besides the small amount of room that they occupy, is that the worker is quite certain of having pure standard reagents, which only require dissolving in water to form the usual photographic solutions.

COMPRESSED GAS

For producing the oxy-hydrogen light (limelight), a hydrogen flame, supplied with oxygen under pressure, plays upon a small cylinder of lime, a spot on which is heated to incandescence. Some years ago the lanternist had to manufacture one or both of the gases employed, but the method is now obsolete, and it is usual to obtain the gases, compressed into steel cylinders, from one of the companies who make a specialty

of supplying them in this form. Photographic dealers and pharmaceutical chemists are generally prepared to obtain compressed gas to order, the charge being so much per cubic foot. Each cylinder needs to be fitted either with an automatic regulator, which will adjust the supply of gas to requirements, or with a reducing valve (*see also* "Cylinder, Gas"). To obtain the best results with a mixed jet, both the oxygen and the hydrogen should be under pressure, although an experienced lanternist can get good results with a mixed jet supplied from the gas main and from a cylinder of compressed oxygen. For ejector and blow-through jets, only the oxygen need be under pressure. For determining the content of a cylinder, a pressure gauge is used.

Compressed acetylene (the gas is dissolved under pressure in acetone) is obtainable, and can be used for lantern purposes.

CONCAVE LENS (Fr., *Lentille concave;* Ger., *Hohllinse*)

A lens that is depressed or hollowed out; known also as a divergent lens. When two faces are concave, as at A, it is described as "concavo-

A. Concavo-concave Lens B. Concavo-convex Lens C. Concavo-plane Lens

concave"; when one is concave and the other convex, as at B, it is "concavo-convex"; and when one of the faces of a concave lens is plane, as at C, it is "concavo-plane." The "biconcave lens" is the "concavo-concave." The "concavo-convex" is also known as a "meniscus" lens.

CONCENTRIC LENS

A lens patented in 1888 by Dr. Schroder and introduced in 1892 by Ross, being perhaps the earliest application of the new Jena glasses in Great Britain to photographic work. It is composed of two symmetrical combinations, each consisting of a plano-convex of glass of high refractive but low dispersive power, and a plano-concave of low refraction but higher dispersion than that used for the convex lens. The two plane surfaces are cemented and the inner and outer curves are concentric; hence the name. The lens has an excellent flat field over a wide angle, and is still esteemed for copying.

CONCENTRATED SOLUTION

A solution made up very strong, chiefly in the form of a stock developing solution, and needing to be diluted with water before use; it may or may not be saturated. It is not synonymous with saturated solution (*which see*), although sometimes thought to be so. Rodinal, certinal, azol, and similar developers are concentrated solutions. The single-solution developer given under the heading "Adurol" is a good example of a concentrated home-made developer. Concentrated solutions are handy for storing; they do not take up so much room and as a rule keep better. Almost any developer with which the worker is instructed to take equal parts of Nos. 1 and 2 (or A and B) may be made in a more concentrated form by simply using half the water given in the formula, and adding the other half at the time of using. Hydroquinone cannot in the ordinary way be made up in a highly concentrated form, but for a "ten per cent." formula *see* "Hydroquinone."

Toning baths are not, as a rule, made up in a highly concentrated form, because of the danger of the gold precipitating, particularly when sulphocyanide is used; the following, however, has been recommended for the use of workers whose dark-room space is limited and who wish to keep a highly concentrated bath:—

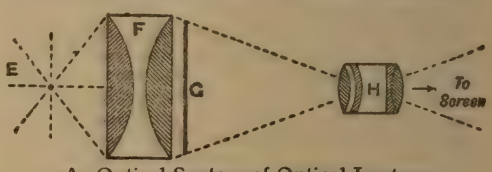
Gold chloride .	8½ grs.	4·8 g.
Strontium chloride .	85 „	48 „
Distilled water .	1 oz.	250 ccs.

Heat the water to 200° F. (93° C.), add the gold, and then the strontium. Next add 7 drms. of water in which 25 grs. of potassium sulphocyanide have been dissolved. Heat again to the same temperature as before, filter, and make up to 2½ oz. with water. This is highly concentrated, and keeps well; when a toning bath is to be made up for use, add ½ oz. of the concentrated solution to 5 oz. of water.

CONDENSATION (*See* "Lenses, Condensation on.")

CONDENSER

In optical projection the condensing lenses cause the rays of light emitted by the lamp or jet to pierce the transparency from all points, the rays being then transmitted to the objective or focusing lens. Diagram A shows the general optical system by which projection is accomplished, E being the illuminant, F condenser, G transparency or slide, and H objective or focusing lens. The condenser shown is the one commonly used. Light rays, unless intercepted, always travel in straight lines and, as indicated at E, in straight lines from their source. This holds good, no matter whether the illuminant be oil, limelight, acetylene, or electric light. For the purposes of optical projection, it is necessary to collect a large angle of these rays, transmit them through the slide, and pass them on to the projecting objective, by means of which a large image is brought to a focus upon the screen placed at some distance beyond.



A. Optical System of Optical Lantern

In cases where the illuminant may be regarded as a point, such as with the limelight or electric arc, many experts consider that the Herschel form of condenser B possesses advantages. Many years ago two lenses of somewhat long focus and shaped as at C, were employed, but this form has

long been obsolete. The forms shown at A, B, and C are capable of collecting a fairly large cone of rays; the lens next the light serves as the collecting lens and for transmitting the rays to the second lens, which bends and converges them towards the objective, as at A. The distance of the illuminant from the condenser governs the angle at which the rays are sent on towards the objective. The triple form of condenser D possesses many advantages for microscopic and other scientific work, inasmuch as it collects a greater angle of light.

In the best condensers the lenses are ground to a sharp edge. The lens next to the illuminant unavoidably gets very hot, and hence should be mounted loosely in the cell, for if at all tight it

B. Herschel Condenser | C. Condenser with Two Long-focus Lenses | D. Triple-lens Condenser

will, in expanding with the heat, become cell-bound, and a crack will probably result. One method of preventing this is to provide the mounts with three or four spring clips or spring rebates, which allow of the expansion of the glass and also of ventilation. The intense heat arising from powerful arc lamps, such as are necessary in kinematograph projection work, tends to overheat the lenses in a very short time, and the danger of breakage is therefore increased. Several makers, recognising this fact, have provided means for the ready removal of the condensers from their cells, so that fresh ones may be substituted at intervals during a display, and this without serious interruption. When using all forms of condensers, sudden cold draughts must be guarded against, or cracking will almost certainly occur.

The bull's-eye condenser, as used in photo-micrography, is described under its own heading.

CONJUGATE FOCI (Fr., *Foyers conjugués*; Ger., *Konjugierte Brennpunkte*)

The distances between lens and object, and lens and image; known respectively as the major and minor conjugate. They are always proportional to the ratio between the size of the object and that of the image. Thus, in enlarging from quarter-plate to whole-plate—a ratio of 2—the major conjugate, or distance between lens and bromide paper, will be twice the distance between lens and negative. If F = focal length of lens and R = ratio, then, whether enlarging or reducing, $F \times (R + 1)$ = the greater distance, or major conjugate; and the major conjugate $\div R$ = the lesser distance, or minor conjugate. If, however, the image is full-size, the conjugate foci are each equal to twice the focal length of the lens.

CONTACT BREAKS

Mechanical devices for automatically "making" and "breaking" the current flowing through the primary winding of an induction coil (*which see*). Several forms of contact breaks are in use, the most popular being the hammer, electrolytic, and motor-mercury breaks. The first-named consists of a metal spring carrying a soft iron head and pressing against a platinum point which completes the circuit when no current is passing through the coil; but when the current is switched on the soft iron core becomes a magnet, attracts the block of soft iron, and draws the metal spring from the platinum point, thus "breaking" contact. The metal spring or "hammer" rapidly vibrates, "making" and "breaking" contact while the coil is working. In the electrolytic break, the current is completed by a platinum point projecting from a porcelain cylinder immersed in an electrolyte. When the current is turned on, electrolytic bubbles immediately form round the metal point and break the circuit; the bubbles disperse, and the contact of the platinum with the water again completes the circuit. The rapidity with which the bubbles form and disperse makes the electrolytic break a highly efficient one. The motor-mercury break consists of a jet of mercury rapidly revolving in a sealed chamber with two or more strips of metal fixed in the sides. When the jet strikes a metal strip the current flows through the coil; when the metal is passed the contact is broken.

Contact breaks make and break the flow of electricity through the coil from a few hundred to several thousand times a minute. In X-ray work an efficient contact break is of the highest importance.

CONTACT, OPTICAL (Fr., *Contact optique*; Ger., *Optische Berührung*)

When two substances are cemented so closely together that there is no air space between, and the four surfaces have apparently been reduced to two, they are said to be in optical contact. A typical example is a pair of lenses cemented with Canada balsam; while the silver coating on a mirror affords another instance. To mount prints in optical contact is to cause them to adhere to suitable glasses, usually bevelled, by means of a warm solution of gelatine. Prints mounted in this way are often known as opalines, presumably because they sometimes have a margin of white paper, which, when seen through the glass, resembles opal. (*See also* "Opalines.")

CONTACT PRINTING AND CONTACT PROCESSES

All printing papers and lantern slides may be printed by contact, the term indicating the placing of the sensitive surface of the paper or plate to be printed upon in contact with the film side of the negative. The alternative method is that of printing by enlarging or reduction through a lantern or camera.

CONTINUING ACTION OF LIGHT

This action occurs only in the carbon and kindred processes of photographic printing; that is, in those that depend on the fact that gelatine and other colloid substances become insoluble when impregnated with an alkaline bichromate and exposed to light. The process of rendering insoluble, once begun by exposure

to light, continues after the print is taken from the frame, even if stored in a perfectly dark place, so that a partially exposed print may be completed by this continuing action. It is, however, very slow and uncertain. It depends on the presence of dampness in the air; and, consequently, it is much more rapid in wet weather than in dry. This continuing action may be entirely prevented by storing the print in an absolutely dry receptacle, such as a calcium storage tube used for the platinotype process. When prints can be developed within a few hours from the time that they are taken from the frames, the keeping of them under moderate pressure between dry blotting-paper is sufficient to prevent any appreciable increase in depth.

CONTRAST

The range of tones in a negative or print, from the highest light to the deepest shadow. A print is said to be flat or lacking in contrast when the highest light is a pale grey, the deepest shadow a medium grey only, and the gradation between the various tones is very slight. A print possesses good contrast when the highest light is either pure white or a very pale tone, the deepest shadow a rich black, and well-marked gradations separate the various details and tones. In nature the range of contrast may be from one to several hundreds; in a print on matt-paper the range from pure white to deep black is about one to twenty-five. In a highly glazed print the range may extend from one to fifty.

CONTRAST, EXCESSIVE

This may exist in a negative or print when the scale of tones is too long for the sensitised film to record satisfactorily. The darker tones will be a mass of black, since the deepest have gone beyond the deepest tone of the paper, while the lighter tones will be a mass of plain white without detail. A familiar example is the blank white sky that is frequently seen in a print when the sky portion of the negative is over-dense. Reduction is the proper treatment for an over-dense negative. (*See* other headings, in particular "Bennett's Reducer.")

CONTRETYPE NEGATIVE

A negative produced by sensitising a gelatine plate with potassium bichromate, drying, exposing under an ordinary negative, and soaking in water containing Indian ink or any coloured dye. The colour is absorbed by those parts of the gelatine not affected by light; and in this way, after fixation, is obtained a duplicate of the original negative, but reversed.

CONTROL IN PRINTING

Methods of treating negatives, or methods of treatment adopted while printing, may be summarised under the above heading. The object in all cases is the same; namely, to produce a better, a more harmonious, or a more satisfactory print than that which the negative would give if the ordinary course were pursued. It is quite incorrect to assume that it is only inferior or imperfect negatives that require such assistance. The more critical the worker becomes with regard to his results, the more will he adopt methods of control. In a large proportion of subjects, the lighting or other conditions may render the resultant negative inharmonious—not necessarily harsh or imperfect technically, but inharmonious in the sense of there being strong lights, or emphasis, in parts where such strength is detrimental to the general effect. It is control for securing true balance of light and shade, and for obtaining the most artistic result, that is the object of the treatment described.

The most simple method of control consists in shielding those parts of a negative which tend to become too dark, while the remainder of the print attains its full strength. In some cases this may be a simple shielding of a small corner or one end, while in others it may be necessary to shield almost the entire plate while a small part prints out fully. In printing by diffused daylight, a piece of thin wood or card may be supported at about ½ in. or 1 in. above the surface of the negative, and covering those parts that attain their full depth too soon. The light diffuses gradually under the edge of the shield, grading softly from full action through the unshielded portions to practically no action at all under the greater part of the shield. The manner in which the change is effected, the sudden or the gradual transition from full printing to no action at all, will be determined by the distance of the shield from the negative. Even if as close as ¼ in., no line or sudden mark will show. In the case of a bright window in an interior photograph, a hole may be cut in a sheet of card, and the card supported above the negative so that the hole is exactly over the window, allowing its details to print out fully while the other parts are restrained. The effects of slight halation may be entirely removed in this manner without any work on the negative.

In printing by artificial light, the same results may be obtained by keeping the shields in motion while they are in use. By that movement, the risk of a sharp line showing is entirely obviated. The greater the extent of the movement of the shield, the softer the transition of its effect.

A second method, which is very useful in those cases in which there is a well-marked line in the subject at which the change in strength of printing should be made, consists in covering the glass side of the negative with very thin tracing paper or ground-glass varnish. The paper or varnish is cut away from those parts that print too slowly. The tracing paper to employ is that sold by artists' colourmen under the name of *papier végétal*, or vegetable tracing paper. It is very thin and translucent. It should be slightly damped and attached to the glass at the margins by a little gum. When dry, parts may be cut away as desired, the edges of the cut parts being secured by a touch of gum. Matt varnish is finer in character, but more difficult to apply. The degree of restraint possible may be increased by using a yellow-tinted varnish. The extent to which parts of a negative are held back in printing by this method is not great, but still sufficient for all ordinary negatives. A negative that has been prepared in this manner can be printed quite successfully by artificial light by the simple expedient of keeping the frame moving slightly during the exposure. In diffused daylight, no movement of the frame

is necessary, the thickness of the glass plate being sufficient to diffuse the light and prevent hard lines showing at the edges.

A third method of controlling results consists in cutting out a mask that will fit exactly those parts which require holding back. The most satisfactory way of making the mask is to take a silver print from the negative, and, having cut out the parts that print too quickly, to fix them to a piece of plain glass the same size as the negative. They should be put on in such a manner that when the glass is laid exactly over the negative the cut pieces will be in the precise position necessary. The printing is commenced in the usual manner, and as soon as the parts that correspond with the mask are sufficiently dark, the glass that bears the cut-out pieces is placed in position, care being taken that the corners coincide with the corners of the negative, thus ensuring that the mask is exactly in position. Although it involves more trouble in printing than does the use of tracing paper or matt varnish, this method possesses the advantage of allowing any degree of restraint to be exercised.

CONVENTION, THE PHOTOGRAPHIC

The Photographic Convention of the United Kingdom was founded in the summer of 1886. Its object was to afford facilities to photographers, professional and amateur, for an annual gathering at some suitable town previously agreed upon, for the purpose of hearing and discussing papers of photographic interest, of holding exhibitions, social outings, etc. The founders were the late J. Traill Taylor and J. J. Briginshaw.

Conventions carried out on this model, but on a much larger scale, have long been popular amongst photographers in the United States.

CONVERGENT DISTORTION (*See* "Distortion.")

CONVERGING LENS

A positive lens, or one capable of bringing rays to a focus; a convex lens. In practice all convergent lenses are convex, or thicker at the centre than at the edges.

CONVERTIBLE LENSES

The single components of a doublet lens capable of being used alone or in combination with other lenses, as in the casket lenses (*which see*).

CONVEX LENS

A lens that is raised in the middle; the opposite to concave. The "convexo-convex" has

A. Convexo-convex Lens B. Convexo-concave Lens C. Convexo-plane Lens

two convex surfaces, as at A; the "convexo-concave," one surface of each kind, as at B (identical with the "concavo-convex" and "meniscus"); and the "convexo-plane," one convex and one plane surface, as at C. The "biconvex" lens is the convexo-convex.

COOLING CHAMBER (Fr., *Chambre réfrigérante*; Ger., *Kühlzimmer*)

An arrangement employed in dry-plate manufactories for cooling the emulsion on the plates and causing it to set as quickly as possible. It may consist of a tunnel-shaped compartment about 15 ft. long, open only at each end, and furnished with an ice tank at the top, while below is a cold slab resting on a metal tray filled with ice water. The plates on coming from the coating machine are received on an endless travelling band of woven wire, by which they are carried along the cold slab and through the cooling chamber, emerging with the emulsion sufficiently set to allow them to be removed.

COOPER-HEWITT LAMP (*See* "Mercury Vapour Lamp.")

COOPER'S PROCESS

A plain, salted paper printing process now practically obsolete. The paper was sized with an alcoholic solution of resin, the silver sensitising solution being afterwards applied. More simple sizing solutions are now used, as described under the heading, "Plain Paper Printing."

COPAL VARNISH (Fr., *Vernis copal*; Ger., *Kopalfirnis*)

Gum copal is a natural product, which is described under the heading "Gums and Resins." Copal varnish is sometimes employed for photographic purposes, a good formula being:—

Copal	2 oz.	110 g.
Oil of turpentine . .	7½ „	375 ccs.
Linseed oil . . .	5 „	250 „

But as such a varnish cannot properly be made by the cold process, and as the heating of oil and turpentine is attended by grave risk of fire, it is better to buy the varnish ready made, advice which applies to all oil varnishes.

COPPER (Fr., *Cuivre*; Ger., *Kupfer*)

Copper has become a most important and almost universally used metal for photo-engraving. It began to supersede zinc, which was formerly used, as soon as the fish-glue enamel process came into vogue, it having been found that zinc deteriorated in the "burning-in" process to which the enamel was subjected. The copper used is mainly of American origin, and this kind is considered the best for the purpose; a considerable amount also comes from the Continent, but this is generally harder, more brittle, and more difficult to etch. The copper comes on to the market in well-rolled and finely-polished sheets of either 16 or 18 B.W. gauge (·065 in. or ·049 in.; the higher the gauge number the thinner the metal). Copper is invariably etched with ferric chloride solution of a strength of 35° to 40° Beaumé (sp. g. up to 1·36).

COPPER ACETATE (Fr., *Acétate de cuivre ;* Ger., *Kupferacetat*)

Synonyms, copper subacetate, verdigris. $Cu(C_2H_3O_2)_2 H_2O$. Molecular weight, 199·5. Solubilities, 1 in 14 water, soluble in alcohol. It should be kept well stoppered. It is a poison, the antidotes being emetics and the use of a stomach pump, then white of egg, charcoal, iron filings, magnesia, or pure potassium ferrocyanide ; avoid milk and fatty acids. It takes the form of bluish-green crystals, obtained by dissolving copper carbonate in acetic acid. It is used as a colour screen in sensitometry. (*See* "Colour Sensitometry.")

COPPER AND AMMONIUM SULPHATE (Fr., *Ammonio-sulfate de cuivre ;* Ger., *Kupferammoniumsulfat*)

Synonyms, ammonio-cupric sulphate, ammonio-sulphate of copper. $CuSO_4 4NH_3 H_2O$. Molecular weight, 245·5. Soluble in water. It is a poison ; for the antidotes, *see* under the heading "Copper Acetate." It is in the form of a dark-blue crystalline powder, and is obtained by dissolving copper sulphate in a solution of ammonia and precipitating by alcohol. It is used as a light filter in sensitometry, and is then prepared in solution as follows :—

Copper sulphate . .	175 grs.	20 g.
Distilled water . .	15 oz.	750 ccs.

Dissolve, and add enough liquor ammoniæ (·880) to redissolve the precipitate first formed and give a deep blue clear solution. Filter, and add—

Distilled water to . .	20 oz.	1,000 ccs.

COPPER BROMIDE (Fr., *Bromure de cuivre ;* Ger., *Kupferbromid*)

Synonym, cupric bromide. $CuBr_2$. Molecular weight, 223·5. Solubilities, very soluble in water, less so in alcohol. It occurs as a greyish black crystalline powder, but it is most easily made by double decomposition, as follows :—

A.	Copper sulphate .	250 grs.	29 g.
	Hot water . .	10 oz.	500 ccs.
B.	Potassium bromide.	238 grs	27·6 g.
	Distilled water .	10 oz.	500 ccs.

Mix the solutions and allow to cool. It has been suggested for use in the intensification of negatives and for bleaching bromide prints for subsequent sulphide toning.

In process work, the copper bromide intensifier is employed for intensifying half-tone negatives, chiefly for the reason that it is more amenable to the "cutting" or reduction which every negative has to undergo in order to sharpen up the dots.

The following is the formula generally employed for making up the copper bromide solution :—

	No. 1—		
A.	Potassium bromide	500 grs.	52 g.
	Water . . .	10 oz.	500 ccs.
B.	Copper sulphate .	500 grs.	52 g.
	Water . . .	10 oz.	500 ccs.

Dissolve A and B separately and mix together, allowing to stand twelve hours before using. The negative is bleached in this solution, rinsed well, and placed until blackened in solution

	No. 2—		
	Silver nitrate . .	1 oz.	55 g.
	Nitric acid . .	40 mins.	4 ccs.
	Distilled water to .	20 oz.	1,000 ,,

Greater density is given by flowing over a solution of either ammonium or sodium sulphide. The copper bromide intensifier is usually employed in conjunction with the cutting or reducing solutions of iodine and cyanide.

COPPER CHLORIDE (Fr., *Chlorure de cuivre ;* Ger., *Kupferchlorid*)

Synonyms, cupric chloride, copper bi- or di-chloride. $CuCl_2 2H_2O$. Molecular weight, 170·5. Solubilities, 1 in ·83 water, very soluble in alcohol and ether. It is deliquescent, and must be kept in well-stoppered bottles. It is a poison ; for antidotes, *see* "Copper Acetate." It takes the form of a greenish crystalline mass, obtained by dissolving copper carbonate in hydrochloric acid, or in a similar manner to the bromide, using 117 grs. of common salt in B solution. It is occasionally used as a reducer, Spiller's formula being :—(1) Alum, 2 oz. ; copper sulphate, 2 oz. ; salt, 4 oz. ; and water, 20 oz. (2) Saturated solution of common salt. Mix equal parts of 1 and 2, immerse negative, and wash.

Also, it has been suggested as an addition to printing out emulsions to increase contrast, and was used in Obernetter's process (*which see*).

COPPER, INTENSIFICATION WITH

A process for intensifying gelatine negatives. A solution of bromo-iodide of copper is prepared as follows :—

Copper sulphate	.	100 grs.	76 g.
Water . .	.	3 oz.	1,000 ccs.

When dissolved, add with constant stirring the following, which must also be dissolved :—

Potassium iodide	.	8 grs.	18·2 g.
Potassium bromide	.	20 ,,	45·6 ,,
Water . .	.	1 oz.	1,000 ccs.

A slight precipitate of iodide of copper of a deep yellow colour forms ; this is allowed to settle and the clear part poured off for use. The fixed and washed negative is placed in the above until bleached and of a canary-yellow colour, from five to fifteen minutes being usually required. The solution may be used repeatedly if strengthened occasionally with a few drops of a mixture made by dissolving 12 grs. of iodide and 36 grs. of bromide in 2½ oz. of water. After bleaching, the negative is washed well, and darkened by placing in a strong solution of sodium sulphite to which a few grains of silver nitrate are added. Good results may also be obtained by darkening with a hydroquinone developer. The colour of the resulting negative is strongly affected by the solution used for darkening after bleaching. The above usually gives a reddish deposit which is very non-actinic ; rodinal a brown image, and the sulphite-silver a darker one. Variations in colour when hydroquinone is used may also be obtained by altering the proportions of sulphite and hydroquinone

Both the bleaching and the darkening must be done in daylight; the stronger the light the better and quicker the results. After darkening, the intensified negative is well washed in water and finally dried. The process may also be used for slides and bromide paper. When used for prints, the paper turns blue when bleaching, owing to the formation of iodide of starch, but the colour disappears when the hydroquinone is applied, and the colour of the print is usually a good brown.

COPPER AND POTASSIUM FERRICYANIDE (Fr., *Ferricyanure de cuivre et de potassium*; Ger., *Kupfer-Blutlaugensalz*)

$KCuFe(CN)_6$. Molecular weight, 314·5. Soluble in water. It is poisonous; for antidotes, *see* "Copper Acetate." This salt is always prepared in solution by double decomposition, generally in the presence of an alkaline citrate. It is used for toning bromide prints and transparencies (*see* "Copper Toning"), and is then reduced to the double ferrocyanide, $K_2CuFe(CN)_6$ (a brownish-red powder insoluble in water), by the metallic silver; white silver ferrocyanide is also formed.

COPPER PRINTING PROCESS

A printing process introduced by Obernetter, based on the fact that copper forms with chlorine a green salt (copper chloride) soluble in water. This salt is sensitive to light, which reduces it to hypochloride of copper. Paper is saturated with a mixture of copper chloride and iron chloride, and when dry is exposed to light under a negative. Afterwards it is immersed in a solution of potassium sulphocyanide, and ultimately treated with red prussiate of potash, a brown picture being the result.

COPPER REDUCER FOR BROMIDES

A process of locally reducing over-dense bromide prints, introduced by Fourtier in 1905. A 5 per cent. solution of copper sulphate is mixed with enough solution of potassium carbonate until no further precipitate is formed. The precipitate is collected on a filter paper and washed with several changes of water, and then dissolved in water to which a few drops of hydrochloric acid have been added. To this clear solution a strong solution of ammonia is added until the precipitate first formed is re-dissolved, the resulting rich-blue liquid being a solution of ammonio-chloride of copper. The actual reducer is:—

Copper solution (as above)	½ oz.	25 ccs.
"Hypo" solution (5%)	½ ,,	25 ,,
Water	20 ,,	1,000 ,,

The prints should be well soaked in water, laid face upwards on a sheet of glass or the bottom of a clean porcelain dish, and the reducer applied with a tuft of cotton-wool. The action of the reducer is stopped by washing the print in water, and the reducer made to work more or less rapidly by varying the quantity of water. The above is really a roundabout method of making copper chloride, and the same purpose is served by mixing solutions of copper sulphate and common salt.

COPPER SULPHATE (Fr., *Sulfate de cuivre*; Ger., *Kupfersulfat*)

Synonyms, cupric sulphate, blue vitriol. $CuSO_4\,5H_2O$. Molecular weight, 249·5. Solubilities, 1 in 2·5 water, 1 in 400 alcohol. It is efflorescent, and should be kept well stoppered. It is a poison; for antidotes, *see* "Copper Acetate." Large deep blue crystals, obtained by dissolving copper carbonate in sulphuric acid. It was occasionally used in the developer for wet collodion, and is now used chiefly for making the bromide, chloride, and ferricyanide salts. It forms a rich blue solution with excess of liquor ammoniæ, and is a useful filter for colour sensitometry and three-colour work.

In process work, copper sulphate is used as an addition to the wet-plate developer. Its action is said to be merely that of retarding the oxidation of the ferrous sulphate. Copper sulphate is also employed by process workers in the copper bromide intensifier. In electrotyping it is the salt used with sulphuric acid to form the depositing solution.

COPPER TONING

A process for toning bromide prints, originally introduced by Eder and Toth in 1876, and modified by Namias and others. The following method, introduced by W. B. Ferguson in 1900, is the most satisfactory. The colours obtained range from warm black, reddish sepia, brown, purple brown, purple crimson, reddish purple, through many shades of red to the so-called red chalk, according to the quality of the print and duration of toning. The Ferguson formula has appeared in many forms, a popular one being:—

A.	Copper sulphate	60 grs.	6 g.
	Potassium citrate	240 ,,	24 ,,
	Water to	20 oz.	1,000 ccs.
B.	Potassium ferricyanide	50 grs.	5 g.
	Potassium citrate	240 ,,	24 ,,
	Water to	20 oz.	1,000 ccs.

Use equal parts of each and immerse the print until the desired shade is obtained. The toning is made more rapid by adding 5 grs. of citric acid per ounce of toner. Used in its normal state the bath produces the first tones very rapidly, while the final colour (red) requires from twenty to forty minutes, according to the quality of the print. Washing for ten minutes only is necessary to stop the action of the toner at any desired stage. The colours are produced by the formation of copper and silver ferrocyanides.

The following copper bath has also been recommended for rich red tones:—

Ammonium carbonate (saturated solution)	1 oz.	1,000 ccs.
Copper sulphate	10 grs.	2 g.
Potassium ferricyanide	25 ,,	5 ,,

Owing to the alkaline condition of this bath it produces red tones more quickly than does the Ferguson formula.

COPPERAS

A common name for various sulphates. Thus, copper sulphate = blue copperas; iron sulphate = green copperas; zinc sulphate = white copperas.

COPPERING SOLUTION

A superficial coating of copper may be applied to etched zinc plates by neutralising copper sulphate with a strong alkali, such as ammonia or cyanide. Previously, the plate is well washed and scrubbed with caustic potash and whiting, and is then immersed in the solution for a few minutes, when it will be found coated with a sufficient covering of copper.

COPYING

Copying should present no serious difficulty provided suitable precautions are taken, and correct exposures given. It is essential that the print to be copied should be held perfectly flat on a board which is parallel with the sensitive plate. If this condition is not observed, a distorted image will result. The arrangement shown at A (p. 145) is simple, inexpensive, and answers well for copying and also for other photographic work. The direction of lighting is important. A direct front light minimises the effect of the grain of the paper, while a strong side light accentuates it. On the other hand, a direct front lighting cannot be adopted for glossy surfaced prints on account of the reflections. To avoid the sheen of the glossy surface, lighting from one side, slightly in front, is necessary.

For copying pictures under glass, the camera front should be covered with a black cloth, and a black or dark cloth should be hung up close behind the camera to avoid reflections. A side lighting is desirable for the same reason; but where the original is liable to show a grain, the lighting should be from two sides. (For copying oil paintings or water-colour drawings, *see* "Paintings, Photographing.")

For copying an ordinary silver print, or any strong photographic print with a glossy surface, a rapid plate will give the most truthful rendering of the gradation. If the print is faded or yellow an isochromatic plate should be used. For copying a line engraving or drawing, or a wash drawing, or a photographic print with very little contrast on matt-surfaced paper, a slow plate specially made for copying, such as a "process" plate or a fine grain ordinary plate, will give the most satisfactory negative. In all cases the plates should be backed. Correct exposure is most important, and the best method of determining this is by using a meter, which should be placed flat against the picture that is being copied and the time that is required for matching the standard tint noted. Using a plate of which the speed is 200 H. & D., the exposure for copying a glossy silver print the full size of the original, and using the aperture marked *f*/16 on the diaphragm scale, will be from one-fourth to one-half the meter tint if a Wynne meter is used, and from one-eighth to one-fourth with a Watkins meter. A dark or red-toned photograph will require longer exposure than a light or cold-toned print. For copying a line drawing, one-half the meter tint for a Wynne meter, and one-fourth for a Watkins will be the correct exposure for a slow plate, 40 H. & D. For a black-and-white drawing in wash, these exposures should be doubled.

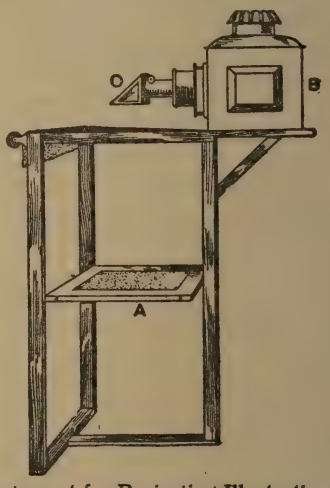
The above exposures are for making a copy the same size as the original. For other proportions, the following will be the relative exposures, the lens aperture being the same throughout:—

	Times the scale of the original	*Relative exposure*
Enlarged to . .	2 ..	$2\frac{1}{4}$
„ „ . .	$1\frac{1}{2}$ ..	$1\frac{1}{2}$
Copying same size	1 ..	1
Reduced to . .	$\frac{3}{4}$ ..	$\frac{3}{4}$
„ „ . .	$\frac{2}{3}$ ..	$\frac{2}{3}$
„ „ . .	$\frac{1}{2}$ ..	$\frac{9}{16}$
„ „ . .	$\frac{1}{3}$ ..	$\frac{7}{16}$
„ „ . .	$\frac{1}{4}$ ..	$\frac{1}{3}$

In process work, the art of copying has been brought to great perfection for photo-mechanical processes, where the reproduction has generally to be made from a print or drawing. The essentials that are carefully studied are: The lighting of the subject; the parallelism of the original to the sensitive surface; the sharpness in definition of the image; and the opacity and clearness of the respective parts of the negative. The first condition is generally secured by electric arc illumination. The second is secured by the use of stands on which are rails, the camera and copyboard running on these rails to and from each other; also by rigid and accurate construction of the camera. The third is secured by the choice of suitable lenses such as are specially made for process reproduction. The fourth is secured by the adoption of suitable plates or processes, the wet collodion process being generally considered the best for such work. Further, it is very important to avoid vibration (*see* "Copying Stand").

COPYING ILLUSTRATIONS FOR TRANSLATION INTO LINE DRAWINGS

A modification of the arrangement that is illustrated and described under the heading "Camera, Vertical" may be used for project-



Arrangement for Projecting Illustrations for Translation into Line Drawings

ing book or newspaper illustrations, when such illustrations are taken from photographs and have to be translated into line. The

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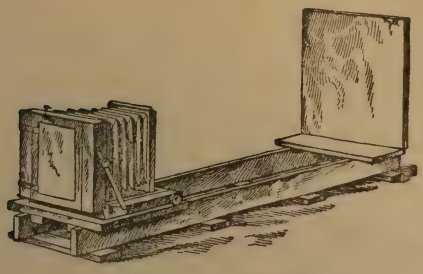
glass platform A (*see* the illustration to the present article) is covered with a drawing-board, and upon this is placed the paper, etc., upon which the sketch is to be made. A transparency made from the illustration to be copied is placed in the lantern B, and by means of a sloping mirror C attached to the lantern lens hood an image of the illustration is projected upon A, where it can be drawn on the paper provided.

COPYING STAND (Fr., *Pied-table, Chevalet de reproduction;* Ger., *Reproduciren-Stativ, Kopier-Stativ*)

An arrangement for keeping the camera and copy parallel when reproducing plans, drawings, photographic prints, etc. It usually consists of an upright copyboard or easel running on parallel rails, and capable of being clamped in any position. The camera may also be mounted to run on the rails, but is often stationary. Illustration A shows an ordinary copying stand.

In process work, the copying stands used are the products of considerable ingenuity, the occasion for which was the necessity of avoiding any want of sharpness through vibration. One



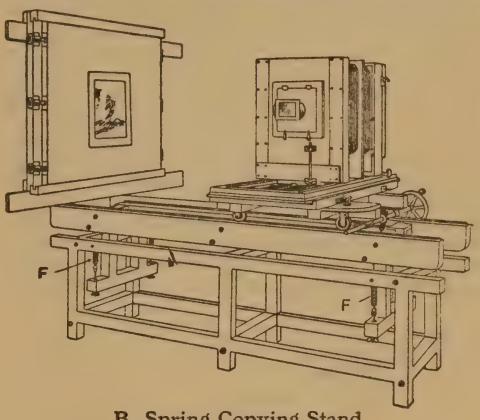
A. Ordinary Copying Stand

of the earliest and most usual methods for attaining this object was to suspend the copying base on ropes which depend from the ceiling; but the ropes get hardened by constant tension and in time fail to neutralise the vibration. One way of overcoming this drawback was to insert spiral springs between the ends of the ropes and the suspension hooks; and another was to suspend the base from a beam swinging like a scale beam.

The above methods are now considered clumsy and obsolete, and the usual form of apparatus now employed is the spring stand B. The base is swung on spiral springs F attached to a rigid stand. Where no vibration is anticipated, rails may be laid on the floor and the camera and copyboard placed on separate stands, with wheels running directly on the rails, or the copyboard may be fixed to the wall whilst the camera is on a running carriage. This system is largely used in Government offices for map reproduction.

Another plan often employed for large work is to have rails laid both inside and outside the dark-room, the copyboard being on a carriage outside, and a plate-holder being mounted on a carriage inside, whilst the lens is fixed in an opening made in the wall of the dark-room; in this way the dark-room itself becomes the camera. Where daylight is used for illumination, tilting stands are sometimes employed in order to get the best light possible on the original.

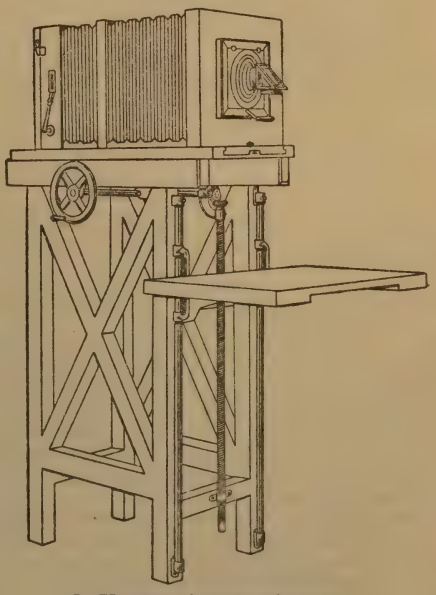
A curious form of copying apparatus used for



B. Spring Copying Stand

copying large paintings in the open air is the revolving camera stand, which can be turned according to the direction of the sun's rays.

The vertical copying stand C is often used for copying from books, or from small natural objects which can be best arranged on a horizontal board. Levy's copying stand D and E combines not only the vertical, but also the tilting and horizontal forms. With these vertical stands a prism or mirror box must be used in conjunction with the lens.

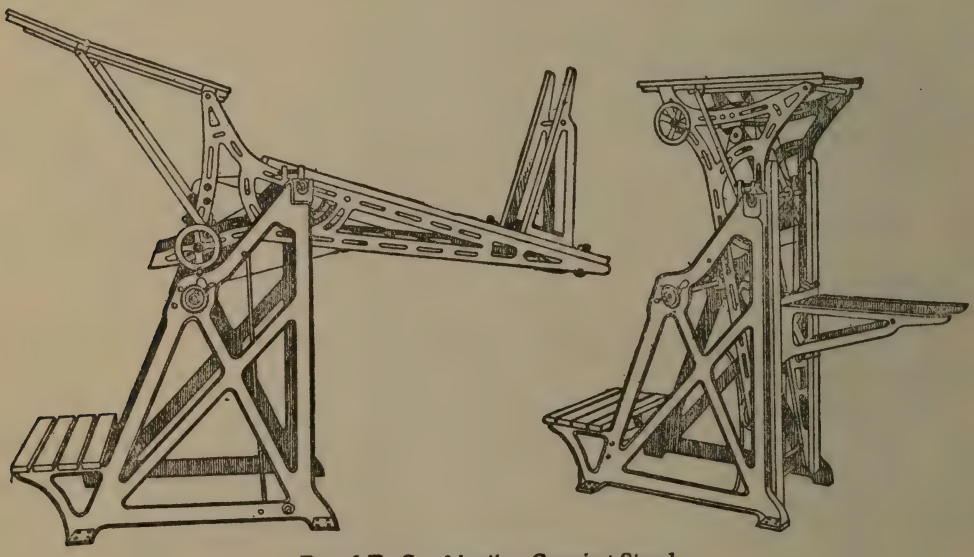


C. Vertical Copying Stand

For producing reversed negatives, which invariably have to be made for photo-mechanical processes, the camera stands must be provided with a turntable so as to place the camera side-

ways to the copyboard, the image being then reflected by mirror or prism, as shown in the vertical stand C. On the Continent, copying stands have been made for such reversal work with the copyboard and the camera carriage both placed across the stand at an angle of 45 degrees, but, of course, still parallel to one another and provided with reversing prism as before. In this way some floor space is saved with large cameras.

For copying transparencies a "transparency attachment" is usually connected up to the camera and stand; it is a simple light-tight conical bellows with provision for inserting the transparency. Rotary copyboards and rotary transparency holders are often employed in copying, especially in colour work, to place the negative at different angles from the vertical or horizontal line. For correcting distortion a transparency holder with universal movement may be employed.



D and E. Combination Copying Stand

COPYRIGHT (Fr., *Droit d'auteur;* Ger., *Verlagsrecht, Urheberrecht*)

Protection against copying and other forms of reproduction is granted to photographs equally with paintings and drawings. The Act by which this protection is afforded is the Copyright Works of Art Act of 1862, the clauses of which Act, taken in conjunction with the judgments of the courts during the years that have intervened since then, cover the many incidents which may arise in the creation of copyright, in its assignment, and in the infringement of copyright works. The Act defines copyright as "the sole and exclusive right of copying, engraving, reproducing, and multiplying any photograph and the negative thereof by any means and of any size"—that is to say, the reproduction of a photograph by another graphic method, such as drawing or painting, may yet be an infringement of the copyright. The Act in another place uses the term "colourable imitation." In other words, a copy need not be an exact copy. It is sufficient to be able to show in the case of the infringement of a copyright that the original photograph has been copied by a mechanical or hand method.

The period of protection granted by the Act is for the term of the natural life of the author and seven years after his death. It has no relation to the life of the owner of the copyright except in the case where he is also the author. Usually, there is no room for doubt as to who is actually the author, but in the case of a photographic firm, where the finished photograph passes through a number of hands, it has been held that the author is the person who effectively is as near as he can be the cause of the picture which is produced—that is, the person who superintended the arrangements by putting the people into position. It has also been held that an absentee principal cannot be the author, even though, by the creation of system in his business, he may be actually just as responsible for the result as though he had been present.

The most important clause in the Copyright Act is that which describes the conditions as to payment when a photograph is taken, because upon these conditions the ownership of the copyright depends. The Act expressly states that when the negative of any photograph is made for or on behalf of any other person "for a good and valuable consideration," the copyright belongs to the person for or on whose behalf the work is done. Thus, in the case of an ordinary sitter in a studio, the copyright is his; in the case of a landscape photographer working for an employer, all copyrights in the views taken are the employer's. The question of what is "good and valuable consideration" has involved some nice points of law. Articles of value, or board and lodging, may be agreed upon as "valuable consideration," and there

is, in fact, one case in which the granting of permission to photograph certain premises was judged to be "valuable consideration" to the photographer because it gave him the opportunity to sell numerous copies of the photographs he had taken.

It should be noted that the Act does not say *on payment of* the consideration, and, so far as the ownership of copyright is concerned, non-payment to the photographer by his customer, or employer, does not give the first-named any rights in the photographs; the copyright remains with the customer or employer, whilst the photographer must sue in the usual course for payment or wages. In cases of doubt as to the ownership of a copyright this forms a useful test. If one is in a position to sue for payment one cannot then have any ownership in the copyright.

The portrait photographer should also note that in the case of negatives taken at the same time as others at the sitting, but not ordered by the customer, the copyright is nevertheless the property of the customer. In cases where this point has arisen it has been held that payment was for the labour of the artist as a whole, and, therefore, covered all the exposures made at the sitting. Any use made of such extra negatives will thus be an infringement of the sitter's rights.

Again, when, as sometimes happens, the portrait of a person is taken by the order and at the expense of a second person, the copyright naturally becomes the property of the person paying, or suable for payment. And, in the absence of any agreement that the photographer should make some negatives for himself at such a sitting, the whole of the portraits taken are the property of the person ordering the work.

Though the Copyright Act does not say anything about the ownership of the negative, it is perfectly clear on one point—namely, that the sale or disposal of the negative by the owner of the copyright to another person without the formal assignment of the copyright in writing to either buyer or seller causes the copyright to be destroyed. This fact should be borne in mind when purchasing negatives or acquiring them along with the purchase of a business. It is necessary to draw up an itemised list of the subjects, sufficient for separate identification, and to have the whole document signed by the vendor transferring the copyright to the purchaser, or by the purchaser reserving the copyright to the vendor, according as the copyrights are, or are not, to change hands.

Before referring to the assignment and registration of copyright, one minor clause of the Act must be noted—namely, that which enacts that any person may copy any work in which there is no copyright, and may represent any scene or object, notwithstanding that there may be copyright in other representations of such scene or object. This clause has a very practical application in the reproduction of the works of Old Masters, in which, of course, there is no copyright, but any number of photographers may make copies of such works and severally acquire rights in their copies, even though these latter are practically identical. Similarly, there is nothing to prevent several photographers from photographing a landscape from a particular point of view; even though the negatives are almost identical, copyright may be obtained by each separate author.

Assignment of the copyright in a photograph may be whole or partial. The sole rights to reproduce in any form or place whatever may be sold with, or without, the negative, though there can be no object in the photographer retaining the negative, since his rights to make a single print from it have been disposed of. It is more usual, however, to assign specifically limited rights to reproduce, such as in a given issue of a journal or newspaper, as a calendar or window-bill, as a postcard, or as an advertisement for a particular class of goods. The nature of the assignment being clearly defined, the photographer is left free to dispose of other limited assignments in other ways, but a form of assignment loosely worded (for instance, the following: "Received of A. B. 10s. 6d. for the right to reproduce my photograph of Trafalgar Square.—C. D.") might be taken to mean the sole rights of reproduction. An assignment or licence to reproduce should clearly state the particular purpose for which the photograph is to be used. In the case of reproduction in newspapers, it is usually understood that the photographer's name should be acknowledged under the photograph, or on the same page, and that no use be made of the photograph without extra payment in extra issues of the paper, or any other publication of the same proprietorship.

Although anyone purchasing the sole copyright in a photograph or other work is thereby at liberty to reproduce it in any form, the Act forbids the alteration of such photograph, or the reproduction thereof in an altered form, during the life of the author and without his consent—that is to say, that such altered version must not be represented as the unmodified work of the originator.

The registration of a copyright is important to those who have business in selling rights of reproduction, inasmuch as the Act provides that "no proprietor of any such copyright shall be entitled to the benefit of the Act until such registration, and no action shall be sustainable, nor any penalty recoverable, in respect of anything done before registration." In other words, registration is a formal claim to rights in the photograph. It is made at Stationers' Hall, on forms provided for the purpose. On this form five columns are provided, but it is only necessary, when registering a copyright, to make entries in Nos. 1, 4, and 5; Nos. 2 and 3 are required only when a copyright is assigned by one person to another. In column 1 a short description identifying the photograph is given, in No. 4 the name and address of the proprietor of the copyright, and in No. 5 the name and address of the author. The author, as already pointed out, may or may not be the same person as the proprietor. This form, filled up on these lines, is deposited at Stationers' Hall, together with a copy of the photograph, the fee for registration being one shilling. The precise form of the photograph is immaterial; a straight print from the negative suffices to protect the photographer's rights regarding the issue of enlarge-

ments or even of worked-up reproductions in colour by hand or by three-colour printing. It is simply necessary that the photograph registered should plainly identify the original work of the author.

Infringement of copyright may take a number of forms. The Act specifically forbids any person to "repeat, copy, colourably imitate, or otherwise multiply for sale, hire, or distribution," or to cause or procure these acts to be done. The phrase "colourably imitate" protects the photographer against piracy of his work by draughtsmen or artists, who might use the photograph as a basis for drawings; it is not necessary, to prove infringement, that the illegal copy should be identical with the original from which it was made.

The Act distinguishes between two classes of infringer: (1) those who in knowledge or ignorance commit one of the acts mentioned above, and (2) those who, with knowledge of the unlawful character of the copies, import or distribute the latter in the United Kingdom. The copyist, or person who employs a copyist, is regarded as liable whether he act in knowledge or ignorance of the copyright, whereas an importer is liable only when he acts with knowledge of the unlawful nature of the copies. It will thus be seen that a photographic enlarger, who prepares an enlargement of a photograph sent to him, is equally liable with the person who gave him the order, and this even though both may be in ignorance of the existence of any copyright. Under the Copyright Act there is no need that a photograph which has been registered at Stationers' Hall should be marked "copyright," but it is a natural assumption that any recent photograph is copyright, even though formal claim (registration) has not been made.

The remedies for unlawful copying granted by the Act are of two kinds: (*a*) penalties and (*b*) damages. As already stated, no penalty can be recovered for any such infringement committed before the copyright has been registered, but damages may be obtained in the case of copies which are *made* before registration and *sold* afterwards. The maximum penalty which can be obtained under the Act is £10 for each unlawful copy, together with the forfeiture by the infringing party to the proprietor of the copyright of all such copies. Formerly, this provision of the Act was interpreted to mean a payment of a coin of the realm for each unlawful copy, and on this basis large sums were formerly obtained in the case of unlawful reproduction in a newspaper of large edition. But a later judgment of the Court of Appeal has held that it is not necessary to fix the total penalty at a sum which, when divided by the number of copies, works out to a coin of the realm. When taking action for penalties it is only necessary to prove the infringement. The photographer must show that the copyright is his property by virtue of the fact that he took the photograph without payment in the original instance, or that it was assigned to him in writing at the time of taking, or that he had subsequently purchased it. In action for recovery of damages he must prove not only his ownership of the copyright, but the damage sustained by the infringement.

Where a registered photograph has been reproduced without permission, it is an easy matter to obtain satisfaction from the offending party, but when the photograph has not been registered the owner of the copyright needs to proceed with some care. He should first register the photograph immediately, and he is then in a position to take such action against the parties still producing, or those selling, the copies as will induce the infringer to settle the matter privately. Very frequently the infringement is the result of ignorance or carelessness, and it is usually good practice to assume that it is so, and to write pointing out the infringement and to ask what the party in question is prepared to do. In this letter it is not wise to name any specific sum which would be acceptable to the photographer. Where the infringement is clearly unintentional, many photographers are prepared to accept twice (or even the same) the fee payable had application for the use of the photograph been made by the publisher.

Copyright, created and registered in England, is secured *ipso facto* in the other countries subscribing to the Berne Convention of International Copyright. These countries are as follow: Algiers, Belgium, Denmark and the Faroe Islands, France and its colonies, German Empire, Hayti, Italy, Japan, Liberia, Luxemburg, Monaco, Norway, Spain, Switzerland, Tunis. Under this Convention the photographer in each country must comply with the formalities of his country (the country of origin), and he obtains in the other countries the degree of protection which is granted to natives in these countries. The degree of protection varies within wide limits among civilised countries. In France, for example, protection is granted only to such photographs which are adjudicated to be works of art, and it would appear that judgment in this respect must be given in regard to each particular photograph, apart from the reputation of the photographer as an artist. In some countries—Germany and Belgium, for example—it is not necessary to register, and therefore it is difficult to discover whether the formalities in the country of origin have been complied with in these cases. In Great Britain—and, indeed, whenever there is any doubt—the safest course is to assume that copyright exists in any photograph, painting, or drawing. G. E. B.

CORALLIN (Fr., *Coralline*; Ger., *Corallin*) Synonyms, pæonine, aurin. A mixture of several complex aniline dyes, which is interesting as being the first dye used to colour-sensitise collodion films. It is not used now, having an extremely weak action on gelatine plates.

CORONA PHOTOGRAPHY

The corona is the brilliant pearly-white luminescence observed round the eclipsed sun during a total solar eclipse, when the ordinary brilliant sunlight is obscured by the intervention of the dark moon. Many attempts have been made by astronomers to observe it visually or to photograph it in ordinary sunlight, but all these have hitherto been unsuccessful, and it is only during an eclipse that it can be examined. There is no limit, either of size or quality, to the apparatus

which can be usefully employed to photograph this wonderful solar appendage, and as indicating what are perhaps extremes, excellent pictures of the coronal streamers have been made with ordinary camera lenses of about 5 in. focal length, and also with large mirror telescopes of more than 70 ft. focal length. Each variety, however, has its special advantages, and the general apparatus may be divided into two divisions according to the scale on which the pictures are primarily photographed. With the small scale cameras, lenses of very great angular aperture can be employed, with all the advantages of extensive flat field and light intensity. These will be most useful for recording the extreme limits of the coronal streamers or rays, which are found to be very different from eclipse to eclipse, so that as complete a record as possible is desirable.

With the large scale apparatus the programme is best confined to obtaining detailed pictures of the brighter regions of the corona near to the sun's disk, and as the light gradations in this region are very great, it is generally found necessary to take exposures of different lengths for the different zones, and develop accordingly, so that the intense portions are not rendered unprintable.

If possible, the most rapid panchromatic plates should be employed for photographing the corona, as the principal part of the corona radiations is in the green near wave length 5,303.

The exposures possible will, of course, depend on whether the observer has the use of an equatorial mounting and driving mechanism or not. If he has not, probably half a second will be the maximum exposure possible with a camera of about 7 in. to 9 in. focal length. When the more elaborate mounting is available, exposures of from ten seconds to four or five minutes are given so as to record the farthest outlying streamers.

Very interesting series of experiments have been tried at several eclipses. For comparison purposes two exactly similar photographic cameras have been used side by side, clamped firmly together so as to move as one. In front of one of these cameras, between the lens and the corona, there has been placed a special piece of apparatus for detecting polarised light, so that if any of the light coming from the solar corona is polarised in any particular direction, the difference will be clearly shown on the photograph by the presence of a series of bands as compared with the image taken with the other camera having the lens alone. By such means it has been satisfactorily proved that a large proportion of the light from the corona is polarised, and it is thought that this may be owing to its being light from the sun reflected from the minute particles of which the corona is assumed to be composed.

By obtaining comparable photographs with the same instruments at intervals during a long period of years it has been noticed that the form of the corona decidedly changes; and these changes are found to be in accord with the changes on the sun's surface as evidenced by the presence or absence of the dark irregular markings called sunspots. When these are very numerous, showing the sun to be very active, then the corona is found to be very extensive in all directions round the sun, long streamers passing off practically in all directions. When, on the contrary, the sun's activity is at a minimum, and there are few sunspots, then the coronal streamers are chiefly confined to the regions on either side of the sun's equator; the regions near the sun's poles are at these times occupied by very beautiful plumes or aigrettes, which have all the appearance of the stream lines shown by a series of filings congregating about the poles of a magnet. This fact has given considerable probability to the suggestion that the solar corona is due to some electro-magnetic discharge from the sun's surface.

CORRECTED LENS

A lens having the chemical and visual foci coincident. A properly achromatised lens is said to be *under*-corrected when, in spite of the addition of a second glass, the blue rays still come to a focus nearer the lens than the yellow, and *over*-corrected when the blue rays come to a focus behind the yellow ones.

CORRECTION COLLAR

A rotating collar sometimes fitted to high-class microscopic objectives. The varying thicknesses of the cover glasses placed over microscopic objects affect the value of the corrections of high-power objectives. The correction collar overcomes this difficulty by varying the separation of the combinations of the objective.

CORROSIVE SUBLIMATE (*See* "Mercuric Chloride.")

COSMICAL PHOTOGRAPHY

So many different subjects requiring special treatment are included in the general class of celestial or cosmical objects that for the majority of them it will be more satisfactory to describe the methods of photographing them under their respective special headings (*which see below*). As regards the actual photographic details of procedure, however, much that is common to all celestial photography may most conveniently be detailed here.

Apparatus.—This will vary from the hand camera to the powerful and specially adapted mechanical camera of the astronomer; they will all, however, have in common the feature of being focused for parallel rays, or, as it is usually termed, set for infinity. The reason for this is that for all practical purposes all celestial objects are so far distant from the earth that any differences between their respective distances are inappreciable. This fact will to many constitute a considerable simplification, as undoubtedly the use of a "fixed focus" camera admits of apparatus being efficiently used in a condition which would be much too rough for photographing objects whose distances were different. In photographic language there is no "depth of focus" difficulty in celestial photography, and the flatter the field of definition given by the lens the more satisfactory will its performance be. This leads at once to the fact that for photographing large areas of sky the modern anastigmat type of lens, giving

critical definition over a large angle, is the most efficient instrument.

In many cases the question of cost may serve to prohibit the employment of a sufficiently large lens camera—or refractor, as it is usually termed—and work of the highest type of accuracy has been done with concave mirror cameras. These involve only the optical working of one surface, and thus for a given sum the instrument may be of a much greater power. Two kinds of reflector have been principally used: speculum metal and silvered glass. The former were excellent, but when they tarnished it was exceedingly difficult to re-polish them without altering the *shape* of the reflecting surface and thus destroying the definition of the image. Most of the reflecting telescope cameras now in use consist of a surface of glass accurately ground to a parabolic form and then coated over with an exceedingly thin film of pure silver. This offers the important advantage that when it becomes tarnished it can be dissolved away in a few minutes and replaced very quickly with a new film without in any way interfering with the shape of the glass surface.

Plates.—For most kinds of celestial photography, excepting that of the sun and moon, it is advisable to employ the fastest plate obtainable, provided that the grain is not noticeably prominent. On account of the subjects being generally of special coloration, the isochromatic or panchromatic plates now so easily obtainable should be preferred to the non-colour sensitive brands, as without them it may be found impossible to render differences which are quite easily noticeable to the eye.

Development.—This will, in general, be exactly the same process as would be used for ordinary terrestrial photography. Again excepting photographs of the sun and moon, the general tendency will be for under-exposure to be experienced, so that the treatment recommended for this should be the normal procedure for astronomical work if harshness in the results is to be avoided. Any of the standard developers may be employed with practically equally good result. Pyro soda, metolquinol, and rodinal are all used by some of the best workers, and there is little to choose between them. In general, no bromide or other restrainer should be used; the negative should be thin and full of detail rather than dense and contrasty. To further this, development should never be over-done, as it is practically impossible to remedy it by subsequent reduction, whereas a thin negative, with detail, may be gradually intensified and re-intensified, by means of mercuric chloride and ferrous oxalate, until the requisite density is obtained.

For copies all the usual media are available. Lantern slides of good astronomical subjects make beautiful and interesting records.

(For details of various subjects *see* "Comets, Photographing," "Corona Photography," "Eclipses," "Lightning," "Moon," "Nebulæ," "Rainbow," "Stars," "Sun," etc.) C. P. B.

COSMORAMA (Fr., *Cosmorama;* Ger., *Kosmorama*)

An early arrangement for the inspection of photographs or pictures. These were laid horizontally on a semicircular table or platform, each picture having an inclined mirror to reflect it to a viewing lens, at which the spectator's eye was placed. The pictures were illuminated by concealed lamps and were inspected in turn.

COSMORAMA STEREOSCOPE (Fr., *Stéréoscope cosmorama;* Ger., *Kosmorama Stereoskop*)

An early form of stereoscope made by Messrs. Knight, in which two large lenses were used having a segment cut off, so that they could be placed with their centres 3 in. apart.

COTTON-WOOL

Prepared from the hairs of the seed of *gossypium Barbadense* and other species of *gossypium.* It has many uses in photography, and the variety known as absorbent cotton and sold in rolls, wrapped in blue paper usually, is the best to use. The very common and coarse variety used for packing should not be used for wiping wet negatives, as it contains grit and other coarse foreign matter, which is apt to scratch gelatine. All negatives should be wiped after the final washing with a wet pad of cotton-wool.

This material also makes a serviceable filter for liquids, a tuft being lightly placed in the neck of a funnel and the liquid filtered through it. It does not filter as thoroughly as filter papers, but it will serve for some liquids, particularly varnishes.

In process work, cotton-wool has numerous uses, and the "absorbent" wool is commonly preferred. A wad of it is generally found the handiest means for cleaning zinc or copper with pumice powder or whiting to remove grease. The absorbent cotton is also used for filtering the albumen-bichromate or fish-glue solutions. The development of albumen-bichromate inked prints is effected with the help of a tuft of cotton. By its means, too, the scum which sometimes forms on wet-plate negatives can often be effectually removed without damaging the negative.

COVER GLASS

A plain glass bound up with a transparency (lantern slide) to protect the film. Also a plain glass used as a cover for the object on a microscopic slide.

COVERING POWER (Fr., *Pouvoir à couvrir;* Ger., *Deckkraft*)

The extent, or boundary, to which a lens will produce a well-defined and properly illuminated image. The circle of illumination produced by a lens is practically the measure of its covering power; but definition must also be considered, for this may not be equally good all over the circle. It is desirable to have a lens which will cover a slightly larger circle than is sufficient to include the size of plate used; otherwise there will be a falling-off of definition and of light when using the rising front. The better the lens the more satisfactory should be its covering power; a good modern anastigmat will readily cover, when stopped down, a plate at least a size larger than that for which it is intended.

COWAN'S DEVELOPER

A formula advocated many years ago by A. Cowan for use with negatives.

No. 1.—Pyrogallic acid	20 grs.	4 g.
Nitric acid .	2 drops	·5 ccs.
Water to .	10 oz.	1,000 ,,
No. 2.—Strong liquor ammoniæ .	¼ oz.	25 ccs.
Potassium bromide .	37½ grs.	8 g.
Water to .	10 oz.	1,000 ccs.

In cases of ordinary exposure mix in equal parts. For under-exposure add more of No. 2, and for over-exposure more of No. 1 and bromide.

A. Cowan also prepared a solution of pyrogallic acid which is always ready for use.

Pyrogallic acid . .	1 oz.	18.3 g.
Citric acid . .	60 grs.	2·25 ,,
Water to . .	54½ oz.	1,000 ccs.

Dissolve the citric acid in water and add the pyrogallic. The solution will contain 8 grains of pyro to the ounce of water, and will keep good for many months. In using it dilute according to formula employed.

Another developer known as "Cowan's" is the following (known also as a citrate of iron developer), recommended for chloride lantern plates :—

No. 1. For cold tones—

Potassium citrate .	100 grs.	200 g.
Potassium oxalate .	30 ,,	60 ,,
Hot distilled water to .	1 oz.	1,000 ccs.

No. 2. For warm tones—

Citric acid . .	90 grs.	180 g.
Ammonium carbonate	60 ,,	120 ,,
Cold distilled water to .	1 oz.	1,000 ccs.

No. 3. For extra warm tones—

Citric acid . .	130 grs.	260 g.
Ammonium carbonate	40 ,,	80 ,,
Cold distilled water to .	1 oz.	1,000 ccs.

In mixing solutions Nos. 2 and 3 it is better to put the crystals into a deep vessel, and, after adding the water, leave alone until all effervescence ceases. It is advisable to make it overnight. To 3 parts of any of the above solutions add 1 part of the following at the time of using :—

Ferric sulphate . .	120 grs.	240 g.
Sulphuric acid . .	1 drop	2 ccs.
Distilled water to .	1 oz.	1,000 ,,

COXIN

A solution of crocein scarlet 3 B and a yellow dye, in which exposed plates were bathed, or which was added to the developer so that they could be developed in daylight; the subject of a German patent in 1902.

C.P.

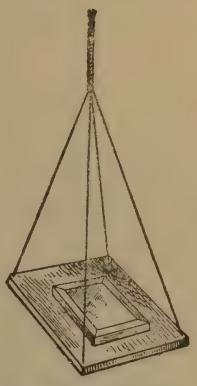
The initial letters of the words "Candle-power" (*which see*). Also an American term placed after the name of a chemical to indicate that it is chemically pure.

CRACKED NEGATIVES

Negatives are easily cracked if cheap frames with uneven beds and imperfect springs are used. The crack may at first appear slight and unimportant, but in time it invariably extends across the plate. With care the film on a cracked negative need not be broken; merely bind the negative to a piece of glass of the same size by means of gummed strips of paper, or cement it bodily to the glass by means of a mixture of Canada balsam and benzole or xylol, the crack being first of all filled in with the mixture.

Many workers duplicate cracked negatives in the following manner. First paint on the glass side and along the crack a fine line of Brunswick black or other opaque varnish, and then make a positive transparency, on which, of course, the crack will be represented by a thin white line. Then, by means of a retouching pencil or a camel-hair pencil and suitable medium, retouch the white line, and make a negative from the transparency. Much depends upon the position of the line and the degree of skill exercised.

There are two systems of taking a print from a cracked negative without the crack showing,



A. Printing from Cracked Negative on Revolving Frame

B. Cracked Negative at Bottom of Deep Box

but the work must be done in daylight. One is to place the frame on a board attached to strings A, and to keep the board swinging or rotating in the shade while the picture is being printed. Another is to place the frame at the bottom of a deep box B, also in the shade. These methods are rather slow, but they give the best results possible with cracked negatives.

It is, of course, possible to remove an unbroken gelatine film from a cracked glass, and one of the best methods of doing so is the following: Carefully clean a sheet of glass one size larger than the negative to be treated, place the cracked negative, film side upwards, upon it, and coat evenly with enamel collodion.

Put on as much as the film will hold without its running over, allow to set thoroughly, and wash till the water runs freely off it; drain, and coat with a solution of 20 grs. of gelatine in 1 oz. of warm water, and allow to set thoroughly. Then immerse the cracked negative with its prepared film in this mixture :—

Hydrofluoric acid .	60 drops	6 ccs.
Glycerine . .	1 oz.	50 ,,
Alcohol . .	1 ,,	50 ,,
Water to . .	20 ,,	1,000 ,,

In a few minutes the film will be free at the edges, and it should then be carefully coaxed off the glass by means of a camel-hair brush and transferred to a dish of cold water. Slip under the released film a sheet of glass coated with gelatine solution made as already stated; or use an unexposed dry plate that has been fixed and washed. Coax out any wrinkles with the camel-hair brush or by blowing, and allow to dry in a horizontal position. If the cracked negative has been varnished, all traces of the varnish must be removed before any attempt is made to remove the film. (*See* "Varnish, Removal of.")

It is possible to do without the collodion, and so simplify the work of transferring the film, but greater care will be necessary. Immerse the negative in 12 oz. of water to which 60 drops of hydrofluoric acid have been added, and after the film becomes loose at the edges, coax it off very gently in the manner already described. Wash for about ten minutes, at the end of which time the film will be enlarged considerably; if required it can be left in the enlarged state, but otherwise it must be immersed in a solution of equal parts of water and methylated spirit until it has contracted to its original size. Then float it upon a gelatine plate as above described.

In the case of a cracked new negative the film may be removed by soaking for about thirty-six hours in a cold saturated solution of common washing soda; all the after operations are as described in the preceding paragraph.

Cracked negatives other than gelatine are best treated as broken negatives (*which see*).

CRACKS IN VARNISH

Cracks upon varnished collodion plates are more common than upon gelatine plates. Negative varnish is essentially a gum or resin dissolved in a volatile solvent. When the varnish is spread over the surface of the film, the solvent evaporates and leaves a coating of the gum resin on the film; as the resin dries it contracts and sometimes cracks. Circumstances that lead to cracking are (1) making the varnished negative too hot (either by heating for the purpose of hurrying the evaporation or by printing in a hot sun); (2) insufficiently washing after fixing; (3) storing in a damp place; and (4) using an unsuitable varnish.

Cracked varnish on a collodion negative may be remedied to an extent by rubbing finely-powdered lampblack, or soot, into the cracks by means of the dry finger-tip or a piece of chamois leather, and then revarnishing.

Cracked varnish on modern gelatine negatives may be treated in the same way, but it is better to remove the varnish entirely and then revarnish. To remove varnish, soak in the solvent which was used for the varnish; if this is not known, methylated spirit may be tried, as most of the resins, etc., used for varnishes are soluble in spirit. After a good soaking rub with cotton-wool and give the negative one or two more soakings in spirit, so as to get rid of the last traces of the varnish. A little ammonia may be added to the second spirit bath with good effect.

CRAPE MARKINGS

A defect met with in wet collodion work, and taking the form of markings having the appearance of crape or fine net work. They are due to the use of too gelatinous collodion or a strong cadmium bromo-iodiser. Solvents too much diluted with water may also cause the defect.

CRAWLING

A developer is said to "crawl" when it does not flow evenly over the film, being prevented from doing so by the greasy surface caused by the faulty condition of the collodion bath; crawling may also be due to an excess of alcohol in the developer. Printing paper is said to "crawl" when it expands or contracts during the progress of printing, as some papers are prone to do. If, for example, a bone-dry paper is put into a frame and placed out of doors in damp weather, the paper may expand during printing and cause blurred outlines of the image to appear. Damp paper put out to print under a negative on a hot day will sometimes show the same effect, through contracting while printing. The defect is more common with albumen paper than any other.

CRAYON ENLARGEMENT (Fr., *Agrandissement au crayon;* Ger., *Stift-Vergrösserung*)

An enlargement usually on rough-surfaced bromide paper, worked up with crayons. The proportion of hand-work may vary greatly, from the mere removal of spots and blemishes to an elaborate amount. Much of the black-and-white work now seen on bromide enlargements is, however, done with the aerograph.

CRAYONS (Fr., *Crayons;* Ger., *Stifte*)

Small pencils of pipeclay, kaolin, or chalk, incorporated with various mineral or metallic pigments, and used for drawing, working-up enlargements, prints, etc. They are obtainable in the form of chalks, as loose points for adjustable holders, or enclosed in cedar pencils. Those employed on enlargements are known as bromide pencils (*which see*). Coloured crayons are used for introducing backgrounds into carbon prints.

In process work, lithographic crayons, consisting of a mixture of wax, shellac, soap, and lampblack, are largely used. A wet-plate half-tone negative can be locally intensified by rubbing a crayon gently over the part where strength is desired. Half-tones can be stopped out for fine etching and vignetting by the use of the crayon wherever required. Lithographic crayons are preferred to black chalks for drawing on grained papers and scraper boards for reproduction, because the work is fixed, owing to its waxy or greasy nature, without further treatment.

CREAM OF TARTAR

A common name for acid potassium tartrate. (*See* "Potassium Bitartrate.")

CRESCO-FYLMA

A name given to a film-stripping and enlarging solution introduced in 1891, the patent on which has now, of course, expired. (For similar solutions, *see* "Film Stripping.")

CRISTOID FILM

A gelatine film introduced as a substitute for glass plates or celluloid, and consisting of two

coatings, the lower one being a slow emulsion and the upper one a fast emulsion. The chief advantage claimed was that errors in exposure were eliminated, because if the upper film was over-exposed a good negative would be obtained on the lower film; also halation was entirely obviated. The film before development was treated with formaline, and, after the usual operations, squeegeed down to plate glass, a bath of alcohol and formaline being used to cause the film to contract to its original size. If this bath was omitted, the expansion of the gelatine due to the absorption of water during the operations of developing, fixing, and washing gave enlarged negatives.

CRITICAL ANGLE

The angle at which a ray passing through a transparent substance is totally reflected. If a thick plate of glass be held between the eye and a light the critical angle will be reached when the inner surface of the glass, either upper or lower, according to position, reflects as from a silvered surface.

CRITICAL ILLUMINATION

In microscopy, critical illumination is obtained by arranging the illuminant, mirror, and substage condenser in such a manner that the image of the lamp flame is seen in the centre of the field when looking through the microscope. Critical illumination is not practicable with low powers, but it is essential when obtaining the finest definition a lens which will give with high powers, and more especially when using the immersion lenses. Recent experiments have shown that critical illumination has been obtained when the back lens, on looking down the tube without an eyepiece, is just filled with light. Daylight cannot be used for critical work. The Nernst lamp is a convenient light for photo-micrography, but for visual purposes an oil-lamp with ½-in. wick gives excellent results. The lamp, with the flame edgeways to the microscope, should be placed with the wick about 9 in. in front of the mirror, which must have the plane side turned to the light. The mirror is placed so that the light is reflected in a direct line through the substage condenser and objective. A diatom slide is placed on the stage and the substage condenser racked up and down till the image of the flame is seen in the centre of the field. If the eyepiece is now removed, the back lens should (providing the substage condenser is of sufficiently high aperture) be filled, or nearly filled, with light. That portion of the field of view only which contains the image of the lamp flame gives critical definition.

If the flame image is a disturbing factor to the work in hand, it can be removed by slightly lowering the condenser, but the definition suffers. Critical illumination is necessary only for powers of ¼ in. and upwards. Low powers should be worked without the substage condenser, and with the concave surface of the mirror turned to the light.

CROOKES' TUBE

The high-vacuum tube (named after the inventor) which produces the X-rays. In an X-ray tube the vacuum is brought to less than one-millionth of the density of the atmosphere. In the original Crookes' tube the cathodal rays were allowed to fall on the glass; this was improved by Prof. Jackson, who caused the cathodal rays to fall on a metal plate connected with the anode (anti-cathode). Another improvement was the cupping of the cathode to allow all the cathode rays to fall on one spot on the anti-cathode, this arrangement constituting the "focus tube." (*See also* under the heading "X-ray Photography.")

CROSS FRONT (Fr., *Décentrement horizontal;* Ger., *Kreuz-Objektivbrett*)

A provision for moving the lens of the camera sideways, so that a little more of the subject may be included at one side or the other, without having to shift the apparatus. It generally consists of a panel sliding in grooved rails, with a clamping screw to maintain its position when adjusted.

CROSSED LENS

A crossed lens is one having its two sides of a similar nature, either concave or convex, but

A. Concave Crossed Lens

B. Convex Crossed Lens

of different curvatures, as illustrated at A and B.

CROWN GLASS (*See* "Glass.")

CRYSTAL CUBE (Fr., *Cube de cristal;* Ger., *Krystall Kubus*)

A stereoscopic device, invented by Henry Swan, depending on an application of the angle of total reflection of glass surfaces. Two rectangular glass prisms are ground to an angle of 39° or 40°, and are placed with their widest sides in contact, or nearly so. One of a pair of stereoscopic photographs is attached to one side of the prism combination, and the other behind. On inspection, the rays from the picture at the back of the glass are transmitted direct to one eye, while those from the second picture are reflected from the surface of the prisms where they touch to the other eye, and appear as if also coming from the back. The two pictures therefore coalesce, giving stereoscopic relief, the effect being as if a solid object were imbedded in the glass.

CRYSTAL MARKINGS (Fr., *Marques cristallines;* Ger., *Krystall Bezeichnen*)

Crystalline or tree-like markings on or under the film of a collodion or gelatine negative. They are usually due to insufficient washing after fixing, and sometimes they do not appear till many days have elapsed.

CRYSTAL VARNISH

A particularly clear varnish, used mostly for lantern slides, autochromes, and other trans-

parencies. There are many different formulæ, and for lantern slides the following is one of the many suitable :—

Gum dammar .	. 125 grs.	52 g.
Benzole . .	. 5 oz.	1,000 ccs.

Apply this cold. For autochromes a stronger solution should be used, namely, 1 oz. of dammar in 5 oz. of benzole, and the plate should be warmed slightly before the varnish is poured on (*but see* "Autochrome Process," where a further formula will be found).

Equal parts of pale Canada balsam and rectified oil of turpentine make a good crystal varnish for maps and engravings, but for fixing pencil drawings 1 oz. of mastic dissolved in 6½ oz. of rectified spirit is recommended. It is not advisable to use crystal varnish for negatives, shellac varnish being better. Another crystal varnish is that known as celluloid varnish, which is largely used for lantern slides. It is a solution of celluloid in acetone or other solvent.

CRYSTALLISATION (Fr., *Cristallisation*; Ger., *Krystallisation*)

A substance or salt when dissolved in water to saturation will gradually deposit crystals, or crystallise out if the water be evaporated. This is called "wet crystallisation." Sometimes a dry salt is fused and allowed to cool, when crystals will also form; this is called "crystallisation by fusion." Again, a volatile salt may be heated, when it will go off in the form of vapour and crystallise on a cool surface; this is "crystallisation by sublimation."

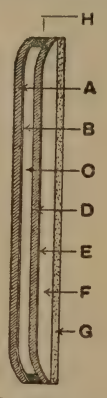
CRYSTALOTYPE

An old name for photographic transparencies upon glass, either in the form of lantern slides or larger plates for window decoration. It was the original English name, "hyalotype" being the American.

CRYSTOLEUMS

Photographs coloured to give the appearance of direct paintings upon glass; known also as chromo-photographs. The system of colouring is about two centuries old, and, before the days of photography, engravings and prints were used as a base, the process being known generally as mezzotinto painting. The advent of photographic prints on paper did much to revive the interest in colouring processes. A modern crystoleum print properly finished looks, as is intended, like a painting upon glass, but actually a transparent photograph comes between the colouring and the glass. The diagram shows the construction of a crystoleum photograph. A is the front glass, on which a photograph B is pasted face downwards. When dry the photograph is made transparent, and delicate details coloured with ordinary oil colours, but the broad masses of colour are not put on. Another glass D, of the same size and shape as A, is put at the back, but is prevented from touching the photograph by means of strips of paper H, which leave a small space at C. On the back E of the second glass are painted the broad masses of colour. The whole is backed up with a piece of flat cardboard or other backing G, leaving a space F. When viewed from the front the colours are seen through the transparent photograph, and the whole has the appearance of a delicately painted picture upon glass.

The working details are as follow: A suitable print is made upon albumen paper, which is the only photographic paper suitable, it being thin and tough. The print is placed in hot water until it becomes quite flaccid, and is then made surface dry by pressure between clean white blotting-paper. A piece of convexo-concave glass (flat glasses are not so suitable), sold specially for the purpose, is then made quite clean, and its concave side coated with clear starch paste or warm gelatine. The damp print is laid paper side downwards upon a flat piece of glass, and its face is coated with the adhesive selected. The print is then placed face downwards in contact with the inner (concave) and prepared surface of the glass, and pressed into close contact. The surplus paste must be removed from between the print and the glass, this being accomplished best by laying a piece of wet parchment over the back of the damp print, pressing out the adhesive with a knife handle or toothbrush handle. The paste must be expelled, also all air-bubbles, by a not too firm pressure, which must be worked always from the centre of the print to the extreme margin. When in perfect contact the parchment is taken away, the back of the print wiped free from any superfluous adhesive, and the whole put aside to dry thoroughly. The correct mounting of the picture is most important, as any errors will spoil the effect.



Section of Crystoleum

When dry the print must be made transparent, and this is accomplished in one of two ways—namely: (1) Rub the back of the print with glass-paper in order to remove as much of the paper as possible (the actual picture being, of course, underneath, next to the glass); a medium glasspaper is used at first, followed with a very fine one in order to remove all scratches, and to lessen the possibility of suddenly penetrating the actual picture on the albumen. When the bulk of the paper has been evenly rubbed away, the glass side of the picture is warmed before a fire, or over a gas-stove, and at the same time a piece of paraffin wax is rubbed on the paper side of the print, the object being to saturate the picture with warm wax. When the print appears equally transparent all over, all superfluous wax is removed with a piece of flannel and the picture allowed to cool. When cold the wax may be further polished, and if not evenly transparent it must again be glass-papered on the dense parts and waxed again. (2) The alternative process consists in leaving the paper print of its original thickness and making it transparent by rubbing into it a solution of ½ oz. of Canada balsam in 3 oz. of either benzene or chloroform, the former being the cheaper. Another solution for the purpose is Canada balsam 2½ oz., paraffin wax 1 oz.,

and white wax 1 oz., heated together and used in the same way as the wax in the first method.

Upon the print prepared as described all the fine details are now coloured, these including the lips, eyes, jewellery, etc. A finely-pointed sable brush is used, and ordinary oil colours slightly diluted with megilp. After the colouring, the second glass is put on at the back and bound by the edges to the first one to keep it in position. It must be as close as possible to the first glass, but not touching, and it may be kept from contact by sticking two or three thicknesses of stamp edging along the edges of the front of the second glass; or a narrow strip of thin cardboard may be used in the same way. The colouring on the second glass may be very crude, the masses of colour being put on the back and care being taken not to overlap the outlines. No details or lights and shades are wanted, as they appear in the picture itself, but body colours only are wanted, these being mixed with a proportion of flake white. The colour already in the print must be considered; consequently, to picture fair hair in a portrait, white tinted with yellow will serve. Upon viewing the picture from the front (holding it over white paper), one can easily judge whether the colouring is correct or not. If not, it may be corrected or removed with a rag and turpentine.

The final operation consists in attaching a piece of white cardboard to the back of the second glass and binding the whole together by means of narrow paper strips, and then framing. Fancy gilt frames are the most suitable, but obviously any may be used. Special solutions for mounting the pictures, making them transparent, and for preserving the transparency and colouring, are articles of commerce. P. R. S.

CUPRIC

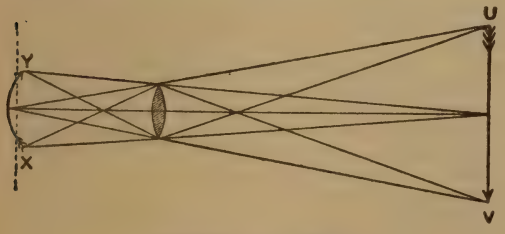
An adjective derived from *cuprum*, the Latin word for copper. (*See* "Copper.")

CUPROTYPE

A printing process invented in 1857 by C. J. Burnett, of Edinburgh. It was on the lines of the ink process (*which see*), copper chromate (*cupric chromate*) being used.

CURVATURE OF FIELD (Fr., *Courbure du champ*; Ger., *Bildwölbung*)

Synonym, aberration of form. A defect in a lens whereby the image of a flat object does not

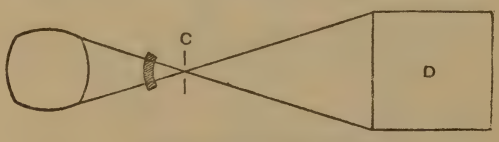


Curvature of Field

lie on a plane surface, but on a curved or saucer-shaped one. Thus, as shown in the diagram, the rays forming the image of the arrow U V render it in space at Y X as curved instead of straight, the result being that if the centre of the image is focused the margins will be out of focus, and vice versa. Curvature of field must not, however, be confused with curvilinear distortion (*which see*)—a not uncommon mistake—for the arrow will be shown as straight on the focusing screen, although of unequal definition along its length. When a lens is subject to curvature of field the best result is obtained by focusing for a point midway between the centre and the margins of the picture, as shown by the dotted line, and using a small stop. Curvature of field may be reduced in compound lenses by increasing the separation, but only at the expense of astigmatism. The introduction of the new Jena glasses has rendered it possible to obtain lenses at once free from astigmatism and possessing a flat field.

CURVILINEAR DISTORTION (Fr., *Distorsion*; Ger., *Verzeichnung*, *Distorsion*)

An aberration occurring in a single lens, whether consisting of only one glass or of several cemented together, which causes straight lines at the margins of the picture to appear curved. If the diaphragm C is in front of the lens, as in A, the image of the square D shows "barrel-shaped" distortion; while when it is behind the lens, "pincushion" distortion is present, as in B. The barrel distortion is usually considered less objectionable, and all single lenses are now fitted with the diaphragm in front. Distortion decreases as the focal length of the lens becomes



Barrel-shaped Distortion

B. Pincushion Distortion

greater, being most apparent in short-focus objectives. It is obviously objectionable for architectural work, or anything requiring accurate reproduction of straight lines. The position of the stop has an important influence; if it is brought nearer to the lens distortion is reduced, but, unfortunately, at the expense of definition. Curvilinear distortion is completely cured in doublet or "rectilinear" lenses by placing the stop in the centre between the two combinations, when one kind of distortion neutralises the other. It is owing to this fact that distortion in a negative may be corrected in enlarging, if the same lens is used as the negative was taken with; for in the enlarging lantern the previous position of the stop is reversed, coming between lens and image (enlargement), instead of between lens and object, which in this case is the negative.

CUTCH (*See* "Catechu.")

CUT-OUT MOUNT

A sheet of cardboard in which an opening—rectangular, circular, oval, etc.—has been cut, generally with a bevelled edge. The print is mounted on a second board, which is placed behind the other. This method of mounting is more generally employed for drawings and sketches than for photographs.

CUTTING

A term used in connection with the sharpening up of the dots in making half-tone negatives, as referred to under many separate headings. (*See*, for example, "Clearing Solutions.")

CUTTING SHAPE, OR MOULD (Fr., *Calibre;* Ger., *Beschneideglāser*)

A template used to guide the cutting knife in trimming prints. It is commonly made of plate glass, though zinc and other metals are occasionally employed. Cutting shapes are obtainable in all sizes, and may be square, oblong, circular, oval, etc. Curiously enough, it is difficult to get a rectangular glass cutting shape with absolutely true and parallel sides. This, combined with the unfortunate ease with which the shapes slip, even in practised hands, together with their liability to get broken or chipped, no doubt explains the growing popularity of guillotine cutters and print trimmers. Cutting shapes with the lower side ground are less slippery than those of plain glass.

CYANIDES

Salts formed by the combination of a metal with the radicle CN. An example is potassium cyanide, KCN.

CYANINE (Fr., *Cyanine;* Ger., *Cyanin*)

Synonyms, cyanine iodide, quinoline or chinoline blue, diamylcyanine. $C_{29}H_{35}N_2I$. Molecular weight, 544. An aniline dye obtained by the action of caustic potash on an alcoholic solution of lepidine-iodo-amylate and chinoline-iodo-amylate. It was for some years the only practical red sensitiser known, but its action was extremely uncertain and its sensitising power weak, and it has been entirely superseded by the newer isocyanines. It occurs in monoclinic crystals having a green metallic lustre, and gives a rich blue solution in water and a more reddish one in alcohol. The aqueous solution is extremely sensitive to light. Cyanine bromide, chloride, sulphate, and nitrate can be prepared by treating the iodide with the respective silver salts but they act in the same way as the iodide.

CYANOFER AND CYANOGRAPHIC PROCESS

Names sometimes given to the Pellet process (*which see*).

CYANOGRAPH

A photographic device for recording the blue light in the atmosphere; invented in 1903 by Maillard and Reiss, of Belgium. The apparatus consists of a driving clock which, at regular intervals, unrolls a short length of a band of sensitive paper, on which is made an exposure, a suitable blue filter being interposed. It has been used chiefly for attaching to captive balloons for the purpose of testing light in high altitudes. In X-ray photography a piece of card is used as a filter, and the rest of the apparatus enclosed in a lead casing.

CYANOTYPE PROCESS, NEGATIVE (*See* "Blue-print Process.")

CYANOTYPE PROCESS, POSITIVE (*See* "Pellet Process.")

CYCLOGRAPH (Fr., *Cyclographe;* Ger., *Cyklograph*)

A panoramic camera designed by A. H. Smith, by which the whole outer circumference, or any portion, of a cylindrical object—such as a vase—may be photographed on a single flat plate. The object is supported on a circular platform, which is made to roll along a straight guiding surface at a right angle to the axis of the lens, so that as it moves forward it also revolves, like a carriage wheel advancing. This is, in fact, making use of the principle of a cycloidal rotation. At the same time, an opaque screen having a narrow vertical slit is made to travel on a parallel path at a speed proportionate to that of the object, in such a manner that each successive portion of the object is exposed to the lens when nearest to the straight surface—or, in other words, when it is at the cusp of a cycloid, and its movement is consequently infinitesimal.

The name cyclograph is also given to a panoramic camera invented by Mons. Damoizeau, which turns in a complete circle, so that the entire horizon, or the inside of a circular building, may be photographed. A band of film is employed, and several circles may be taken in succession on the same band if required.

CYCLE, CAMERA ON

There are many opinions as to which is the best plan of carrying a camera on a cycle, much depending upon the size of camera and amount of apparatus it is desired to carry. Many of the pocket and folding cameras need not be considered, as they go into the pocket and do not inconvenience the rider in any way; but it is advisable to carry them in an inner pocket rather than an outside one, chiefly to protect them from road dust. A favourite method of carrying larger and unpocketable cameras is to strap them firmly to the middle of the back of the rider; very broad shoulder-straps will be found less tiring than narrow ones. If the camera is not held firmly it may work round under the arm, and cause considerable inconvenience when riding, and possibly an accident when dismounting or turning a corner. Commercial carriers are made to fix either in front of the handle bars or behind the saddle. Front carriers are to be preferred, as the camera is then always in sight; if placed behind the rider, it is apt to be forgotten when dismounting, and the rider may be thrown. Cameras when carried on a cycle should always be wrapped in a waterproof focusing cloth or other covering, or be enclosed in a proper bag or case, in order to protect them from road dust, which otherwise

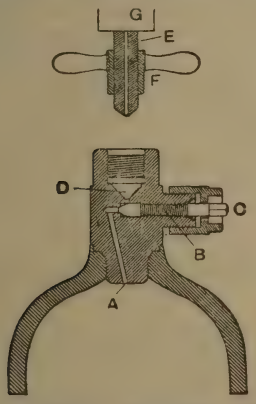
will cause pinholes on the negative, and possibly interfere with the working of the shutter and plate-changing mechanism. Tripods may be strapped to the handle-bar, on the fork of the machine, etc.; some individuals prefer to strap them under the flap of the case, which rests on the front carrier, and attach the projecting ends to the handle-bars.

CYCLOL

A one-solution developing mixture introduced in 1892, and consisting of rodinal, eikonogen, and hydroquinone. (*See* "Developers, Mixed.")

CYLINDERS, GAS

Annealed steel cylinders, tested hydraulically to withstand a pressure of 3,000 lb. per square inch, and charged with compressed gas—oxygen, hydrogen (generally, coal-gas), dissolved acetylene, etc. Periodical re-annealing is necessary, and the gas compressing companies will not take the risk of filling cylinders unless their regulations in this connection are complied with. The construction of the valve is such that all dust and grit should be prevented from entering it; and therefore before connecting the fittings the valve should be opened for an instant so that the rush of gas may dislodge anything in the way. Cylinders of compressed gas are used by the lanternist, who must become familiar with



Section of Cylinder Valve and of the Stem and Adapter of Fitting

the working of the valve, a cross section of which is shown in the illustration. The valve is screwed into the cylinder, the gas from which leaves by the narrow passage A when the spindle B is slightly withdrawn by turning its squared portion C by means of a key; the gas passes to the lantern fittings through the inverted cone D. The gas-tight joint with the automatic regulator or reducing valve (one of these is necessary to reduce the pressure of the gas and provide a convenient means of attaching the rubber tubing), is made entirely by mechanical means, and all daubing of the screw threads with soap, grease, red-lead, etc., must be strictly avoided; accidents have been caused in this way. The stem E of the regulator or reducing valve is itself threaded, and has an adapter F upon it. Screw this adapter close to the shoulder G of the fitting; without any relative movement between stem and adapter, screw the latter into the cylinder valve; in this way the cone on the end of the stem will go home into the inverted cone D of the valve. When it can go no further, it may be found necessary to undo the fitting by, say, the third of a turn, and then screw the adapter in as far as it will go. Cylinders and fittings for oxygen are frequently painted black, and for hydrogen red; on the former the screw threads are right-handed, and on the latter left-handed. (*See also* "Limelight.")

CYLINDERS, LIME

Cylindrical pieces of lime, small portions of the surface of which are heated to brilliant incandescence by a flame supplied with oxygen under pressure. Limes are sold packed in tins, but those put up singly in sealed glass tubes are the most generally convenient. They rapidly disintegrate when exposed to air. The chief point in their use is to turn them frequently to prevent deep pitting. (*See also* "Limelight.")

CYLINDRICAL PERSPECTIVE

Photographs taken with cylindrograph or other panoramic cameras of the half circle form are said to be in cylindrical perspective. (*See* "Cylindrograph" and "Cylindroscope.")

CYLINDROGRAPH (Fr., *Cylindrographe*; Ger., *Cylindrograph*)

A panoramic camera invented by Captain P. Moëssard, in 1889, with which photographs embracing an angle of 170° may be taken on a celluloid film bent to a semicircle. The film holder or dark-slide is flexible, so that it adapts itself to the required form when inserted in the camera. The lens is made to rotate on a vertical axis passing practically through its optical centre; while a tube terminating in an upright slit near the surface of the film is rigidly attached to the lens setting. When a lens is swung on its optical centre the image remains stationary; the various portions of the semicircular film therefore receive the parts of a continuous picture, while the moving slit ensures that only that part directly opposite the lens is exposed as the latter moves. This form of camera has been of much value in photographic surveying, for vertical lines may be ruled at regular distances apart on the photograph, to indicate the relative angular positions of the different objects on a horizontal plane; or a glass ruled with similar lines can be laid on the photograph for the same purpose. To inspect the views in correct perspective, an instrument known as the cylindroscope (*which see*) is employed.

A panoramic camera on much the same principle was designed by Marten, of Paris, in 1845, for use with curved daguerreotypes.

CYLINDROSCOPE (Fr., *Cylindroscope*; Ger., *Cylindroskop*)

An instrument designed by Captain P. Moëssard for the inspection or exhibition of panoramic views obtained with his cylindrograph camera (*which see*). The print is curved to a radius agreeing with that occupied by the film in the camera, and the point of view is in the centre, a suitable eye-lens being used if necessary.

D

DAGUERRE, LOUIS JACQUES MANDÉ

Born at Cormeilles, a village near Paris, November 18, 1789; died July 10, 1851. Inventor of the diorama (1822) and of daguerreotypy (1838). He began his photographic experiments about 1824 by unsuccessful attempts to fix the images in the camera obscura; his neglect of his diorama and scene-painting business caused his wife to seek advice with regard to his sanity. In December, 1829, he entered into partnership with Niepce, who for fifteen years had been working on the same subject, and who had made some important discoveries which he now shared with Daguerre. The two worked together up to the time of Niepce's death (1833), when Isidore Niepce took the place of his father. Five years after the death of the elder Niepce, Daguerre accidentally discovered the process which bears his name, and in the same year (1838) made an unsuccessful attempt to form a company to work the process. In July, 1839, Daguerre divulged his secret and published the process at the request and expense of the French Government, who awarded him a life pension of six thousand francs on the condition that the process should not be patented; notwithstanding this condition, a patent was taken out in England in 1839. Daguerre wrote *Historique et Description des Procédés du Daguerréotype et du Diorama* (1839), and *Nouveau Moyen de Préparer la Couche Sensible des Plaques Destinées à Recevoir les Images Photographiques* (1844).

DAGUERREOTYPE PROCESS

The earliest commercial photographic process, the invention of Louis Jacques Mandé Daguerre. By its means a photographic positive image is produced on a polished silver surface. It was published in France, in July, 1839, and during the next twelve years attained great popularity, but the introduction of Frederic Scott Archer's wet collodion process, in 1848, soon had the effect of rendering the older process obsolete, and it is now not practised except experimentally. Being the first in the field, extreme interest naturally attaches to it, and it has been thought desirable to explain its working in detail.

Daguerre's process, as slightly modified in details by the inventor in the course of its commercial practice, is the one here described, it being impossible in the space at command to discuss the many modifications introduced by other experimenters during the ten or twelve years following 1839. Briefly, a daguerreotype photograph is an image formed by mercury vapour upon a silver-coated copper plate. The process comprises five operations, namely, cleaning and polishing the silvered plate, sensitising, exposing in the camera, developing, fixing and finishing. The sheet copper was silvered either electrically or mechanically. In England, as a rule, Sheffield plate was employed, this being made by soldering silver to copper to form an ingot and then rolling to the required thickness. The most perfect polish upon the silvered surface was necessary, and to obtain this it was cleaned with weak nitric acid and polished with pumice powder, tripoli, and olive oil, the final polish being applied with buffs made of velvet, the plate having been previously heated to drive off the oil. For the purpose of heating during polishing, the plate was supported upon an iron wire frame A, and heated with a spirit lamp. It was essential to obtain a high polish, and dozens of methods of securing this were suggested.

The second operation, sensitising, was modified quite a number of times. In Daguerre's original plan the plate was subjected to fumes of iodine, until it assumed a definite golden yellow. If the action of the iodine was prolonged, a violet

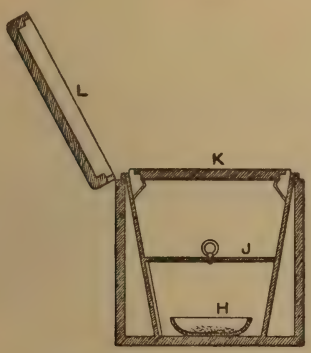
A. Wire Frame used by Daguerre for Supporting Silvered Plate While Polishing

colour was produced, and this was much less sensitive to light. Daguerre's iodising box B had double walls. The vessel of iodine H had over it a ring supporting a piece of wire gauze. The small lid J was in position only when the box was not in use. The plate to be iodised was attached to the underside of the proper lid K; the lid L enclosed the whole. The sensitising took a long time, as the crystals of iodine had to remain in their natural state, and must not be heated because of the possibility of moisture condensing upon the plate. The vapour caused silver iodide to be formed on the silver plate, which was then sensitive to light. Although Daguerre appeared to be satisfied with plates prepared in this way, many other photographers tried to increase the sensitiveness. Goddard, for example, in 1840 exposed the iodised plate to the action of bromine vapour, thereby forming silver bromide upon the plate in addition to the iodide; and in 1841 Claudet used chlorine vapour in the same way; either of these modifications reduced the exposure by about four-fifths. Bingham followed with bromide of lime, which for a time was widely used. These accelerators caused the yellow film to assume

other hues, and in each case the plate was put back again to the iodine fumes until it assumed a rosy hue.

The third operation was that of exposing the plate in a camera (for Daguerre's instrument, *see* "Camera"), and, as in the case of modern dry plates, the time of exposure depended upon the actinic value of the light, etc. Daguerre's times of exposure in Paris, and with plates prepared simply with iodine, are said to have been from five to thirty minutes; objects in shadow, even in the brightest weather, required twenty minutes at least. The daguerreotype plate, however, in its modified form needed only from five to thirty seconds, according to subject, light, etc. It was not an uncommon practice, when Daguerre's original process was used, to whiten the face of the sitter by means of powder in order to shorten the exposure for the face; then, in order to bring out the details of the dark objects, such as the dress, a piece of black cloth attached to a long stick was held in front of the sitter's face during the time the extra exposure was given to the dress.

An obvious defect in a daguerreotype picture

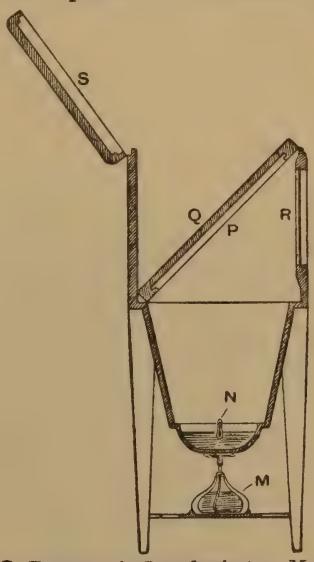


B. Daguerre's Iodising Box

taken in an ordinary camera was that the image was reversed, exactly as in a ferrotype (or tintype) portrait. To obviate this, it was necessary to reverse the image by means of a mirror attached to the lens, thus increasing the already lengthy exposure by about one-third.

The fourth process was that of development, or "mercurialisation" of the image on the exposed plate. The latter was taken into the dark-room and placed in a dark box C in such a way that the surface was suspended over a saucer of mercury heated to a temperature of about 140° F. (60° C.). The box had under its bottom a lamp M, which heated a dish of mercury in which was a thermometer N. The plate P, as removed from the camera, was held in a grooved blackboard Q, where it could be viewed through the glass panel R. The lid of the box is shown by S. The fumes of the mercury "developed" the image in the course of about twenty minutes. The final operation consisted in removing the unused iodine from the plate of silver in order to prevent the further action of light. A saturated solution of common salt was first used, and later a weak solution of sodium hyposulphite. The developed plate was placed in filtered rain-water for a second only, and then immersed in one of the fixers just named until the yellow colour had quite disappeared; warm distilled, boiled, or filtered rain-water was then allowed to run in a stream over the plate in order to wash it. The shadows were represented by the polished surface of the silver, and the lights by the adhering and very delicate film of mercury, which, if fingered in any way, would be wiped off. Therefore, in order to preserve the pictures, they were placed under glass and the air excluded. In some cases the picture was treated with a solution of gold and sodium hyposulphite, which brought out the details with greater force and brilliancy. This idea was originated in 1840 by Fizeau, of Paris, who used a solution of 7 grs. of gold chloride in 10 oz. of distilled water, this being mixed with a solution of 30 grs. of sodium hyposulphite in 4 oz. of water.

The expense of the silvered plates was a



C. Daguerre's Developing or Mercurialising Box

great drawback to the daguerreotype process. As late as 1853, the price charged for a quarter-plate daguerreotype portrait was fifty shillings, and for a half-plate eighty shillings. It was the custom to "improve" daguerreotype pictures by colouring them. Colours ground extremely fine were used and dusted on dry with a fine camel-hair brush, the process needing great care, as it was almost impossible to remove any of the colour applied. When the colours were on they were breathed upon to make them adhere. Claudet's method was to mix the colours with alcohol, and apply cautiously with a soft brush, and to dust on dry colours if the liquid colours were not dark enough. The colours chiefly used were gold, carmine, chrome yellow, and ultramarine, by combining which any desired tint could be obtained.

Major-General Waterhouse has found that daguerreotype plates can be developed with a wet collodion (physical) developer to give a

positive image as usual, or with an alkaline developer, or with ferrous oxalate, to give a negative image. If before exposure the plates are treated with an alcoholic solution of erythrosine, they show sensitiveness to the less refrangible end of the spectrum. Copper plates sensitised with iodine and bromine yield images if exposed and developed with ferrous oxalate or an alkaline developer, and the results are fairly certain.

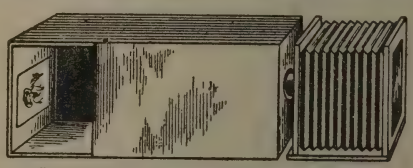
DAGUERREOTYPES, CLEANING AND RESTORING

Cleaning and restoring a daguerreotype picture is at all times a risky process, and should not be attempted unless the worker is particularly careful and patient. Many methods have been advocated, but they all need care and thought, and rather than run the risk of ruining a picture it is better for the uninitiated to leave the work alone. It must be remembered that daguerreotypes are valuable relics, and that comparatively few modern photographers know how they were made. The pictures become indistinct and dull, not by fading, as the modern photographer understands it, but as a result of the oxidising influence of the atmosphere, which has been unwittingly allowed to act upon them, either because the hermetic sealing was imperfectly executed, or because it has become broken away. In this article is described the method of cleaning and restoring that is considered to be the most reliable, but before any attempt is made to improve the picture the processes by which it was produced should be thoroughly understood (*see* "Daguerreotype Process"), the restorer will then know the composition of the photograph. This photograph consists of a most delicate film on the surface of a silvered plate, not varnished or protected in any way, and susceptible of injury from any rubbing or abrasion. Flicking off the dust with a silk handkerchief, or lightly touching the surface with the finger or a camel-hair brush, may ruin the picture. The operator must first try to ascertain whether the picture is in its original state, and whether there has been an earlier attempt to clean or restore it, because should certain chemicals have been left in the film the picture may be ruined when others are applied.

The usual and best method of restoring a faded or discoloured daguerreotype is as follows: Take out the plate from the frame and immerse the discoloured picture in a 1 per cent. solution of potassium cyanide in distilled water, carefully rocking the dish until the milky or smoky appearance caused by oxidation disappears. If the cyanide solution is not strong enough it may be strengthened, but particular care must be taken to use the purest of distilled water, and not to touch the picture with any solid substance, even with cotton-wool. As soon as the discoloration (oxidation) has vanished, the plate must be gently but thoroughly washed in several changes of distilled water, avoiding ordinary water. Finally, it is dried by gentle heat in an atmosphere as free from dust as possible, and in nine cases out of ten the simple treatment will have restored the picture and made it almost, if not quite, as good as new. If, however, the restored picture lacks brilliance and detail, it may be redeveloped, but as the latter process is particularly risky it should be attempted only in extreme and very bad cases. Redevelopment is done by exposure to the fumes of mercury, and not by the application of any liquid. Procure an air-tight box about 3 ft. high; at the bottom place a small spirit lamp, and over it a saucer of pure metallic mercury. Carefully fix the plate to be redeveloped to the lid of the box in such a way that the picture is face downwards when the box is closed. Close the box so that the picture may be exposed to the fumes of the mercury, and examine every minute to see how development progresses. When all detail is restored, remove the plate. Care must be taken during this process not to inhale the fumes, as they are poisonous. Lay the redeveloped plate on a piece of clean, clear glass, and bind the edges with silk strips, using Canada balsam as an adhesive; this binding must be done thoroughly in order to exclude the air. Redevelopment is rarely necessary, and is to be avoided on account of the risk to both plate and operator.

DAGUERREOTYPES, COPYING

Daguerreotypes are difficult to copy satisfactorily because of the character of the image and the presence of the silvered plate. They must be illuminated by a strong sidelight, all other light being cut off, and the surroundings should be dead black, in order to prevent reflec-



Method of Copying Daguerreotype

tions. Professional copyists place the daguerreotype picture inside a deep box lined with velvet, black cloth, or painted a dead black, with a hole cut in one end, through which the camera lens peeps. At the end nearest the picture, part of the side of the box is cut away in order to admit the sidelight, which light should preferably be strong sunlight. As a general rule, the picture should lie on its side, with its top edge facing the direction of the light, because the marks of the buffer sometimes show upon the original picture, and as these lines run from top to bottom they would be accentuated by a light striking them at right angles. Focusing, stop, exposure, plate, etc., are the same as for ordinary copying, the whole secret of daguerreotype copying being in the arrangement of lighting.

DAGUERREOTYPES, ELECTROTYPING

(Fr., *Electrotypage des daguerréotypes*; Ger., *Galvanoplastik der Daguerreotypen*)

The daguerreotype plate to be electrotyped is immersed in an acidified copper sulphate solution, as employed by electrotypers, and is connected by means of copper wires to an electric battery or other source of current. A sheet of soft copper is placed in the solution to form the anode, this being also connected to the

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NIGHT PHOTOGRAPHY

battery. A fine coating of copper is thus gradually deposited on the daguerreotype, but the relief obtained is naturally very slight.

DAGUERREOTYPES, ETCHING (Fr., *Gravure des daguerréotypes à l'acide chlorhydrique*; Ger., *Aetzen der Daguerreotypen*)

A process for obtaining intaglio plates from daguerreotypes, suitable for photogravure printing, was introduced in 1840 by Sir W. R. Grove the inventor of the Grove cell. The daguerreotype was immersed in a solution of one part of hydrochloric acid to two parts of water, and attached to a wire from the battery, which consisted of a pair of Grove cells. Opposite the daguerreotype, and about 2 in. away from it, was placed a platinum plate connected with the other pole of the battery. On the passage of the current, an oxychloride of silver was formed, and at the expiration of about thirty seconds the etching was complete. The oxychloride having been removed, the plate was ready for printing from in an ordinary press. The results obtained were, however, too shallow for anything but very delicate work, and proved unsuitable for commercial use. In 1843 A. J. F. Claudet patented a method of etching the daguerreotype plate with acid, but the specification is by no means clear.

DALLAS RUBBER-TYPE

An invention of Duncan C. Dallas, comprising the making of a swelled gelatine relief, and from it a plaster cast, the cast forming the mould for a vulcanised indiarubber cast to be used as a stamp, or in a press.

DALLASTINT, DALLASTYPE, ETC.

Duncan C. Dallas was the inventor of a number of processes based on the swelling of gelatine, when sensitised with bichromate and exposed to light. Dallastint was a process in which the half-tones of a photograph were reproduced by causing the gelatine to reticulate into a grain resembling that produced in the collotype plate. The effect was similar to that of aquatint, and it was capable of rendering fine detail and delicate gradation of tone. However, the process never came into practical use, and the details were kept secret. The inventor claimed that the process could also be used for decorative purposes by transfer to pottery, stone, wood, etc., and for printing on calico, linen, and other textile fabrics.

Chromo-Dallastint was an adaptation of the Dallastint process to colour printing by making blocks for each colour.

Dallastype was a process proposed for making relief blocks for typographic printing. The inventor made half-tone blocks, and used a ruled screen instead of, or sometimes in combination with, his reticulated grain. The blocks were made of type metal, evidently cast in plaster moulds taken from the gelatine relief.

DALLMEYER, JOHN HENRY

J. H. Dallmeyer (born 1830, at Loxten, near Versmold, Prussia; died off the coast of New Zealand, 1883) came to England in 1851 and entered the workshop of W. Hewitt, optician, afterwards working for Andrew Ross. He started in business for himself in 1859, and in 1862 came to the front as a manufacturer of photographic lenses. He made many improvements in telescopes, and patented a single wide-angle lens (1864) and a lantern condenser. He married Hannah, daughter of Andrew Ross, was elected F.R.A.S. in 1861, and retired from active work in 1880.

DALLMEYER, THOMAS ROSS

T. R. Dallmeyer, son of J. H. Dalmeyer, born 1859; died December 25, 1906. Designed many important optical instruments, lenses for telephotography being perhaps the most important. Among his inventions are a rapid triple cemented landscape lens and a rapid rectilinear landscape lens. He was a prominent member of the Royal Photographic Society, and President of that body from 1900 to 1903.

DALLMEYER - BERGHEIM LENS (*See* "Bergheim Lens.")

DAMMAR (*See* "Gums and Resins.")

DAMMAR VARNISH

Gum dammar dissolved in benzole, chloroform or turpentine makes a clear varnish, which may be used cold and applied, if necessary, with a brush. It is particularly suitable for film negatives, transparencies, etc. (For formula, *see* "Crystal Varnish.")

DAMP, PRECAUTIONS AGAINST

Damp plays havoc with apparatus and sensitive material, which should always be stored in a dry, airy place. Camera bellows become mouldy in a damp place, lenses spotty, cameras may come to pieces, and dark-slides refuse to fit or draw out, and shutters to work. Preventives are obvious. Where possible, it is advisable to use, for home-made articles, a glue that has been damp-proofed by mixing with it while hot one-quarter its bulk of linseed oil, stirring rapidly during the addition. The addition of 1 part of potassium bichromate dissolved in the least quantity of water to 6 parts of melted glue, made with as little water as possible, makes a waterproof cement, which must be stored in the dark until required for use. A precaution against damp is to have cameras and dark-slides brass-bound. Dampness in a dark-room may cause the detachment of labels from the bottles of chemicals, unless these labels are protected by a coat of waterproof varnish extending over their edges upon the glass.

Plates and papers deteriorate quickly if not kept dry; and if damp is suspected they should be kept in a cupboard or in drawers, with some calcium chloride in a tin, either without a lid or with a perforated one; the chemical absorbs moisture, and when it becomes wet it may be dried on a hot shovel or in an oven and used over and over again.

Damp must also be guarded against while printing, as damp paper will probably spoil any negative with which it is placed in contact (*see* "Silver Stains"). When printing is carried out in wet weather, and there is a likelihood of the paper absorbing moisture, it is advisable to use

a pad of waterproof sheeting between the back of the paper and the frame back, or pads of blotting-paper may be used if dried before a fire after taking each print. Such a precaution is particularly necessary when P.O.P or platinum paper is used; and in very wet weather such papers may with advantage be dried before a fire previous to printing.

Carbon paper (tissue) is insensitive when wet and sensitive when dry; but it is not generally known that the film is insensitive when in a state of absolute dryness amounting to complete desiccation.

The walls—plain or papered—of dark-rooms or work-rooms where photographic material is stored may with advantage be covered with a waterproof varnish formed of naphtha and shellac, in the proportion of ¼ lb. of the former to 1 quart of the latter. The smell of the mixture is unpleasant, but soon wears off, and the wall is covered with a hard coating utterly impervious to damp, and to which wall-paper may, if desired, be attached.

A wooden erection used as a studio, dark-room, or store-room, can be given a waterproof coating with tar, which is as effective as, and cheaper than, anything else. The following is also suitable, and can be applied with a brush: equal parts of pitch and resin melted together in a bucket over a stove, and then, after removal, thinned with petroleum ether or paraffin oil. The fire risk in preparing this stuff is considerable, and the job should be done in the open air.

DANSAC-CHASSAGNE COLOUR PROCESS

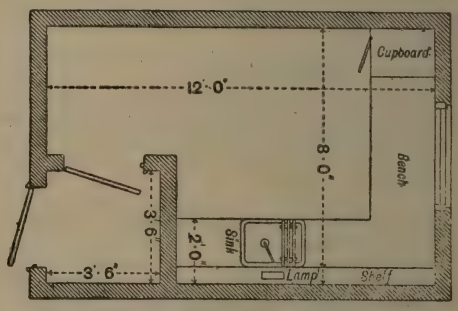
A process of obtaining prints in natural colours, which was introduced in 1897, and originally said to be based on the selective absorption of the silver image for the colours used. On critical examination it proved to be nothing more than local painting with solutions of aniline dyes in albumen.

DARK-ROOM, OR DEVELOPING CHAMBER (Fr., *Laboratoire;* Ger., *Dunkelzimmer, Dunkelkammer*)

A room or cupboard devoted principally to the operation of development, and from which all white or actinic light is excluded. Until A. J. F. Claudet patented, in the 'forties, the use of coloured media, preferably red, the developing chamber was really in total darkness; but since then the name of "dark-room" has been somewhat of a misnomer.

The old idea that space is unimportant in the room used for developing is quite erroneous, particularly with respect to efficient ventilation, so necessary to the health and comfort of the operator. It is obvious, also, that greater convenience is secured when there is plenty of room for shelves and benches, and for moving about. Daylight, owing to its constant fluctuation, is not recommended, and does not add to the safety of the developing chamber, since sunshine or bright light tends in time to bleach non-actinic fabrics and materials, and mischief may be done before this is noticed. It is preferable to block out all daylight and to rely entirely on artificial illumination. It is now realised that, provided the colour of the light is carefully chosen to match that region of the spectrum to which the particular plate employed is least sensitive, a much better illumination is permissible with safety than was at one time imagined, so long as the plate is not unnecessarily exposed to the direct rays from the lamp. The old-style dark-room, where the operator fumbled uncertainly in a dim, ruby glimmer, knocking over bottles and breaking glass measures in his inability to see a foot before him, is rapidly giving way to saner arrangements. In a properly designed developing chamber some means should be adopted for preventing the admission of light when the door is opened. One way of doing this is to have a double door, as indicated in the illustration which shows how a room 12 ft. by 8 ft. may be fitted up as a dark-room. Another way is to curtain off a kind of alcove in front of the door, using a heavy opaque material.

An abundant and pure water supply is an important consideration if much work is to be done. Iron pipes should be avoided, as rust is objectionable in dealing with some sensitive surfaces. If a constant supply cannot be had, a portable tank with a tap or siphon, or even a couple of large pails, may be used. Swing rose



Plan of Fitted Dark-room

taps should be fitted if possible; ordinary taps are more troublesome, giving too forcible a jet and having a marked tendency to splash. But if an ordinary tap is provided as well, for use in filling bottles only, added efficiency is gained. The more shelves that can be fitted the better. Those which will hold the bottles or articles most frequently in use should be low down and well within reach. A small cupboard, with drawers to hold unexposed plates and papers, will be found extremely useful.

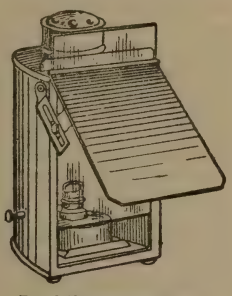
When a room cannot be kept permanently for developing, a bathroom, or even a cupboard, may be adapted temporarily for the purpose. If the work is done at night, and no outside lamps are near, there will be no need to obscure any windows that may be present; otherwise a wooden frame may be made to fit closely in the opening, and covered with any opaque or non-actinic fabric. This is readily removable when not in use, and may be replaced in a few seconds. Portable dark-rooms of various kinds are obtainable, and some of these fold into a very small space. (*See also* "Dark-room Illumination," "Dark-room Lamp," "Dark-room Ventilation," "Developing Bench," etc.)

DARK-ROOM CLOCK (*See* "Clock, Dark-room.")

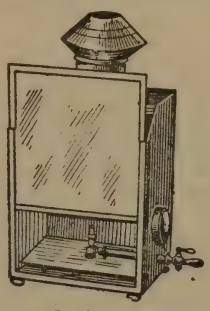
DARK-ROOM ILLUMINATION

The colour of the light used for dark-room illumination is important, both as regards its purity and its general character. For ordinary negative work a pure red, that does not allow any blue rays to pass, is best, and for bromide printing a golden yellow or orange will give sufficient safety with comfort in working. For most colour-sensitive plates a pure deep red is best; but for some that are very sensitive to red a special screen for the dark-room lamp is sold by the makers of the plates. For all ordinary plates and papers the best method for working satisfactorily is to light the dark-room brilliantly, sufficiently well for seeing all bottles, measures, plate boxes, etc., clearly and distinctly. Unless there is sufficient light for working in comfort, inferior results are inevitable. The room should be lighted well, but the plate should be shielded or protected from the direct rays of the lamp, both in filling the slides and during development. The plate may be brought near the lamp for a few seconds, when necessary, for examination, but otherwise should be shielded as much as possible. It is not necessary to cover the dish, as the light reflected from the walls has very little power; but the dish should be 2 ft. or 3 ft. from the lamp and shielded from the direct rays. Artificial light is very much safer for dark-room illumination than daylight, and should always be used when convenient.

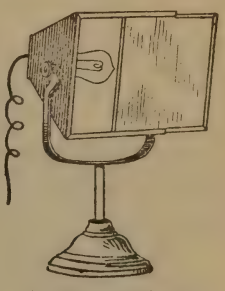
A. Folding Candle-lamp



B. Oil-lamp with Outside Wick Adjustment



C. Gas-lamp



D. Electric-lamp

DARK-ROOM LAMP (Fr., *Lampe de laboratoire;* Ger., *Dunkelzimmerlampe*)

On the satisfactory working of the dark-room lamp depends much of the operator's comfort when developing, while the "safety" of the light emitted is an important consideration. This is qualified to a great extent by the kind of plate or paper that is being used, and its particular region of colour sensitiveness. Thus, for wet collodion plates an amber-coloured glass may be used; for bromide paper, one or two thicknesses of yellow fabric; for ordinary plates, one thickness of orange fabric and two or three thicknesses of yellow, or an amber and a ruby glass together; while for orthochromatic plates a very deep ruby or a special shade of green may be employed. Obviously, therefore, the ideal dark-room lamp is one that will permit the insertion of glasses or fabrics of different colours according to the work in hand. With transparent glass a good deal of light is often wasted; lamps with fabrics capable of diffusing the light, or fitted with sheets of ground glass or opal in addition, for the same purpose are to be preferred, as the room is then more comfortably and uniformly lighted, and the bench, shelves, etc., are more readily perceived. For temporary use, as when travelling, a folding lamp A burning a candle or night-light is convenient; but for constant work candles are troublesome and uncertain. Oil lamps are fairly satisfactory, if fitted with the wick adjustment outside, as in B, and kept scrupulously clean; but gas and electricity are the only forms of illumination that can really be recommended. From the facility with which it may be raised or lowered, gas is perhaps the best of all, if perfect ventilation is secured; and a good pattern of gas lamp is shown at C. A lamp for use with electricity is illustrated at D; hanging electric lamps are also obtainable. The worker should be warned that many of the red incandescent electric bulbs in the market are unsuitable for photographic employment, unless masked with non-actinic fabric.

With regard to the "safe light" used in the lamp, care must be taken that it is suited to the plate. A good way of ascertaining this is to place an unexposed plate in the dark-slide, with the shutter half-drawn, and to expose it close to the lamp for about four minutes. It should then be developed, when, if the light is unsafe, the exposed half will be fogged, and a clear line of demarcation will be evident between it and the unexposed portion. The exact matching of the light to the plate can only be done by photographing the solar spectrum on the latter, and noticing the region of the spectrum which has no photographic effect. It is then possible to obtain a dark-room light of the particular colour, or mixture of colours, to which the plate is insensitive, by bringing the spectroscope into service. Gelatine films, stained with aniline dyes, are much used as safe lights, as their colour may be nicely adjusted when staining. These require to be kept between two plain glass plates in the lamp. Since heat is detrimental to the stained gelatine films, lamps of special construction are made for use with them. Other lamps have glass cells in front, which may be filled with potassium

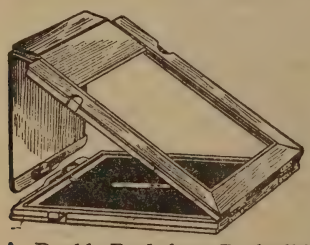
bichromate solution, or a solution of any selected aniline dye. (*See also* "Bichromate Lamp.")

DARK-ROOM VENTILATION (Fr., *Ventilation du laboratoire;* Ger., *Dunkelzimmer-ventilation*)

Adequate ventilation of the developing chamber is essential to health. Perhaps the simplest means of securing it is by the provision of light-traps (*which see*) at the top and bottom of the door, or in any other suitable places. Unless, however, these communicate with the outer air, the ventilation obtained will scarcely suffice. It is as important to secure egress for the foul air as to admit fresh, a fact which is often overlooked, and outlets should invariably be placed at the top. It is not at all uncommon to find small dark-rooms merely provided with ventilation apertures near the floor, in which case it is next to impossible for the vitiated and heated air in the upper part of the room to escape. A light-trapped cowl in the roof forms a very efficient outlet, but proper attention then requires to be paid to the provision of openings for the admission of fresh air at or near the bottom of the room; or the cowl will merely serve to direct a stream of fresh air downwards, and will cause an unpleasant draught. It is often found necessary to use an external electric fan, either to drive in the fresh air or to draw out the foul, but care must be taken not to raise dust. Whenever dust is found to enter by ventilation openings, muslin stretched over a light frame should be interposed before the aperture.

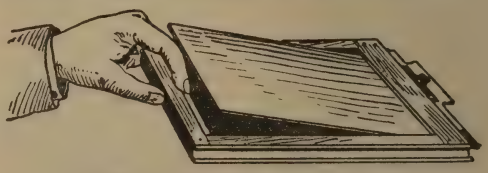
DARK-SLIDE, PLATE-HOLDER, OR BACK (Fr., *Châssis, Châssis négatif;* Ger., *Kassette*)

A light-tight case to hold the sensitive plate or film, always furnished with a shutter or shutters, and made to fit closely at the back of the camera, from which it may be withdrawn at will. There are several kinds of dark-slides. That commonly used with studio cameras has a hinged door at the back for the insertion of the plate, and some of the larger and better-class studio slides have roller shutters instead of those that draw out. Field camera dark-slides are generally hinged in the middle, and open like a book, taking two plates with an opaque cardboard or metal separator between



A. Double Book-form Dark-slide

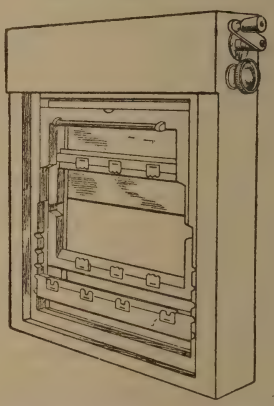
them. These A are known as "double book-form" dark-slides. The shutters are usually cut across and hinged, so that they will fold over the back of the slide when drawn, and be out of the way. Many hand cameras have solid double slides, known as the American pattern, with pull-out shutters of ebonite or aluminium. These are not always perfectly light-tight, especially when they get worn. An improved pattern is shown at B. The shutters do not pull right out, and particulars of the exposure may



B. Improved Solid Dark-slide with Pull-out Shutters

be written on them. To insert a plate, a lever at the bottom is pressed downward (*see* illustration B), and the plate then drops into position, the lever returning and securing it. Metal and cardboard dark-slides are also made. There are many special kinds of slides or adapters, to take film-packs, plates in daylight-loading envelopes, etc. Roller slides (*which see*) are intended for use with roll-films, and are furnished with a winding key and spools.

In process work, the dark-slides are essentially different from those used in ordinary photography. The plate is generally held by means of adjustable bars, the bottom one being placed in a notch corresponding to the size of the plate, and the top one sliding down to rest on top of the plate (*see* illustration C). The metal catches to prevent the plate from falling outwards are of silver when the slide is used for wet-plate work. Sometimes the bottom bar is formed into a trough, to catch the silver drainings, and in an American dark-slide known as the Benster plate-holder a glass trough was let into the wooden bar. For half-tone work the dark-slides are provided with an additional pair of



C. Wet-plate Holder for Process Work

bars to hold the ruled screen, and in some forms of holder these bars are adjustable so as to give more or less separation of the screen from the plate. Most of these process dark-slides have roller shutters.

DARK-TENT

Used for changing and developing plates. (*See* "Developing Tent.")

DARLOT

A noted French optician and lens maker, who made a speciality of casket lenses, under which heading they will be found fully described.

DAVIS FOCUSING SCREEN

A screen used for high-power work in photomicrography, invented by George E. Davis. It is used in place of a glass screen for final focusing, and consists of a piece of wood, preferably mahogany, containing seven holes, any one of which can take an "A" photomicrographic eyepiece.

DAVY, SIR HUMPHRY

Born at Penzance, December 17, 1778; died at Geneva, May 29, 1829. President of the Royal Society, 1820; made many important chemical discoveries and first decomposed chemical compounds by means of electric currents, preparing in this way sodium, potassium, etc. Assisted Thomas Wedgwood in his experiments with light upon silver and described them in the *Journal* of the Royal Institution (1802); in the same year he discovered that silver chloride gave better results than silver nitrate in the preparation of a sensitive surface. He made a number of photomicrographs, or macrographs, by throwing enlarged images of small objects through a solar microscope upon sensitised paper and white leather, but he failed to fix them.

DAYLIGHT CARTRIDGES

This term is applied to spools of flexible film used in cameras specially adapted for them. The strip of film is attached to a considerably longer strip of black paper. The spool is placed in position in the camera, and one end of the black paper is put through a slot in an empty spool and wound taut. The camera is then closed. By continuing the winding, the first section of the film is brought into position for exposure, and the successive sections are in turn wound along. A number on the black paper behind each section can be observed through an opening in the back of the camera, thus regulating the winding and indicating the number of the exposure. When the last section has been exposed, the rest of the black paper is wound on to the spool to protect the film, and the camera can then be opened, the exposed spool removed, and a fresh one inserted. The film thus exposed may be cut up into sections, or developed in the strip either by hand or by means of developing machines made specially for the purpose. The device is an exceedingly convenient and popular one. The smallness and lightness of the cartridges as compared with plates, and the ease with which successive spools may be used are strong points in their favour, especially with travellers.

One precaution in the use of film cartridges may be mentioned: care should be taken not to allow the black paper to run loose on the spool, as this will allow light to creep in at the edges. Also, in folding cameras, avoid winding the film while the camera is closed, as some part of the bellows or lens may touch the film and cause scratches upon it.

DAYLIGHT CHANGING

There are several methods by which plates or films may be changed in daylight without the necessity of resorting to a dark-room. Some that come more or less in this category are referred to under the headings "Changing Bags," "Film Pack," and "Daylight Cartridges." In addition to these, there are special slides made into which plates or films may be inserted singly. A popular form is one in which each plate or film is enclosed separately in a light-tight envelope. The drawing of the shutter of the slide opens the envelope, which is again closed as the shutter is pushed in. The exposed plate in its envelope may then be removed and a fresh one substituted. The number of exposures is thus only limited by the number of envelopes employed. This permits of the provision of plates and films of different character, which may be selected as required.

DAYLIGHT DEVELOPMENT (Fr., *Développement en plein air;* Ger., *Tageslichtentwickelung*)

At various times many methods have been suggested for doing away with the dark-room for development, and they may be divided into two main types: (1) those depending on the use of a light-tight tank with ruby glass sides into which the plate and developer are introduced either in a dark-room or tent, the progress of development being observed through the red windows; and (2) those in which red or non-actinic dye solutions were added to the developer so as to protect the plate from daylight. (*See* "Developing Machine," "Developing Tank," etc.)

DAYLIGHT ENLARGING

The oldest method of enlarging, details being published in the *Athenæum* dated July 9, 1853. A solar camera (*which see*) was used by the early workers, and enlargements were made upon albumen or other sensitive "contact" paper. Bromide paper, as used to-day for enlarging, was not commonly obtainable commercially until 1879 or 1880, although introduced five years earlier. (For modern methods of daylight enlarging, *see* "Enlarging by Daylight.")

DEAD BLACK

Recipes for dead blacks are given under the heading "Blackening Apparatus."

DECIGRAMME, DECILITRE, DECIMÈTRE, ETC. (*See* "Weights and Measures.")

DECOMPOSITION OF LIGHT (*See* "Light.")

DEFINITION (Fr., *Définition;* Ger., *Definition*)

The degree of sharpness with which objects are rendered by the lens. As a rough standard for purposes of comparison, it is generally assumed that the allowable "circle of confusion" shall be one-hundredth of an inch in diameter —that is to say, a circle of that size shall be accepted as a satisfactory rendering of what should be a point. This only holds good for

contact prints from the negative, as it is obvious that any enlargement would increase the error proportionately and so bring it above the standard limit. Some forms of lenses give a curved or saucer-shaped field, so that when the centre is sharp the definition falls away towards the edges. This defect may be counteracted by using a smaller stop. Variation in definition also arises from the inability of a lens to bring to a focus objects on all planes at the same time. Improvement in this direction also is brought about by the use of a small stop. It is not always necessary or even advisable to have equally sharp definition in all parts of the subject, and judicious selective focusing is frequently of great advantage. Some lenses are specially constructed to enable the operator to introduce at will any required degree of softness or diffusion over the entire area. Such softness of definition is often most effective in portraiture and in some classes of outdoor work. It is generally out of place in architecture, copying, and the rendering of subjects for scientific purposes. In such cases the standard of critical definition should be one two-hundredth of an inch or less, and this standard is easily attained by good-class lenses. This matter is pursued further in the article appearing under the heading "Depth of Definition," which should be read in conjunction with the above.

When spherical aberration is entirely absent the centre of the field will be so sharply defined that the most delicate sensitive film is too coarse to register the smallest details. The structure of the sensitive film varies from that of the daguerreotype, which is practically grainless, through albumen on glass, collodion, and slow gelatine emulsions, until the rapid gelatine emulsions which show a granular structure even when magnified only a few diameters. (For the extent of definition which may be reasonably expected from a given type of lens at full aperture, *see* "Field of Lens.")

DEKAGRAMME (*See* "Weights and Measures.")

DELIQUESCENCE (Fr., *Déliquescence;* Ger., *Zerfliessung*)

A property by which certain chemical salts, etc., absorb moisture and become "watery" on exposure to the air. Ammonium sulphocyanide and potassium carbonate are examples of deliquescent bodies. Such chemicals should be stored in a bottle tightly corked, or made up in solution. (For list of deliquescent substances, *see* "Chemicals, Storing.")

DEMENEY CHRONOPHOTOGRAPHE (Fr., *Chronophotographe Demeney;* Ger., *Demeney Kronophotograph*)

A kinematograph machine introduced in October, 1893, by Demeney, and improved two months later by the addition of the "dog" or cam motion, which may be described as an eccentric roller that pulls down one picture-length of film each time it comes round. This is the first recorded instance of the employment of that now well-known movement in the kinematograph. Since then, the chronophotographe has been added to and elaborated. (*See also* "Kinematograph.")

DENSITOMETER (Fr., *Opacitémètre;* Ger., *Dichtigkeitsmesser*)

An apparatus for testing the density of a given negative as compared with an average or standard negative, and estimating the time that will be required for printing. In Dawson's densitometer, a dense part of the negative to be examined is held in front of a suitable source of light, and a screen illuminated by the light that is transmitted is compared with a similar screen receiving light from the same source through a diaphragm, the aperture of which may be varied.

DENSITY (Fr., *Densité;* Ger., *Schwarzung*)

The relative weight of silver deposited per unit area and expressed mathematically as $= -\log._e T$ or $\log._e O$, T = transparency and O = opacity, or, for convenience in working, it is usually taken as $= -\log._{10} T$. As defined by Hurter and Driffield, the law which would produce absolutely true tones would be expressed by saying that the quantity of silver reduced on the negative is proportional to the logarithm of the light intensity. Unfortunately, great confusion exists generally in the use of the terms "density" and "opacity," and the very common expression, "a very dense negative," is a typical example, inasmuch as what is really meant is a negative with great opacities—that is to say, the "opacity" of the silver deposited is so great that there is very little transparency. By the application of a simple factor, densities can be at once converted into the weight of silver per unit area.

DENSITY CALCULATIONS

In photo-chemical investigations it has been found that, assuming that the times of exposure can be divided into the four periods of under-, correct, over-exposure and reversal, the ratio of two densities in the period of under-exposure are exactly equivalent to the ratios of the two exposures, or that the amount of silver reduced per unit area is directly proportionate to the exposure. In the period of correct exposure the densities are exactly proportional to the logarithms of the exposures, and this is expressed by the formula—

$$D = \gamma (\log. It \pm C)$$

in which D = the density, γ = a constant depending on the duration of development, It = the product of the intensity of the light and time, and C = a constant dependent upon the speed of the plate.

The law connecting density with exposure may be calculated by means of the following formula—

$$D = \gamma \log._e \left[O - (O - 1)\, \beta \frac{It}{i} \right]$$

in which D = density, O = the opacity of the plate to the chemically active rays, β = a fraction the hyperbolic logarithm of which is $-\frac{1}{O}$, It = the exposure, and i = the inertia of the plate.

DENSITY CURVE (*See* "Plates, Testing.")

DENSITY MEASUREMENTS

The measurements of densities are always effected with some form of photometer.

DENSITY, OR SPECIFIC GRAVITY (*See* "Specific Gravity.")

DENSOGRAPH

A photometric instrument designed by Dr. Goldberg, based on the use of neutral tint wedges, for obtaining automatically the characteristic curve of a plate—that is to say, for expressing the relations between the densities and their corresponding exposures.

DEPOSITS ON NEGATIVES AND PRINTS

Fine granular or chalky deposits, usually caused by lime in the tap water used for washing. Films allowed to dry with deposit adhering will feel rough to the touch, but the printing qualities of a negative are but seldom affected. Such deposits are best removed by gently wiping the surface of the negative, straight from the washing water, with a pad of wet cotton-wool. Methylated spirit or Baskett's reducer may be lightly applied to remove dried-on deposit.

The peculiar form of deposit that sometimes results from the use of an alum bath is due to insufficient washing, either before or after using the alum solution, a combination of chemicals forming with the alum deposits on, in, or under the film. Alum is very dangerous to the life of a gelatine film when it becomes mixed with certain other chemicals. Fixing baths containing alum may be decomposed by the alum and form deposits. There is no known method of removing deposits caused by alum. If a hardening bath is necessary, formaline should be used, as it does not form a deposit. (*See also* "Black Spots" for a peculiar form of deposit on prints.)

DEPTH OF DEFINITION, DEPTH OF FIELD, AND DEPTH OF FOCUS

"Depth of field" is sometimes used as synonymous with "depth of focus" and "depth of definition," the third expression more correctly indicating what is meant. Theoretically, objects on different planes, however small their separation, are brought to a focus by the lens at different points. In practice, however, it is found that there is a certain range within which objects are rendered with a satisfactory degree of sharpness. The distance between the nearest and the farthest sharp object is the depth of definition. The two chief factors regulating this are the focal length of the lens, and the size of the stop employed; the shorter the first and the smaller the second, the greater is the depth of definition; the longer the focal length and the larger the aperture, the smaller is the depth of definition. If a lens is focused on a very distant object, and then slightly racked away from the screen until the limit of critical definition in the distance is reached, it will then be in the position which gives the greatest depth of definition. The nearest point showing satisfactory definition will vary according to the focal length and the stop, as already stated. The rule for finding the exact distance (known as the hyperfocal distance) on which to focus to secure this greatest depth, is as follows: Square the focal length of the lens (in inches), multiply by 100, and divide by the *f* number. The answer gives the hyperfocal distance (in inches). Halving this distance gives the nearest point of critical definition.

When a nearer object is focused upon there is a certain distance both before and behind it within which the definition is also up to the standard laid down. The amount of this depth for any distance, lens, and stop, may also be calculated. Let H be the hyperfocal distance (inches) for the given lens and stop, D the distance (inches) focused for. The nearest point of critical definition is then $(H \times D) \div (H + D)$; the farthest point is $(H \times D) \div (H - D)$. The range of good definition is always greater beyond than before the actual point focused upon. It follows that in estimating a distance to which the focusing scale is to be adjusted (as in hand-camera work) it is better to under-estimate it than otherwise.

A lens is sometimes said to have a deep focus when it renders both near and distant objects sharply at one time; but as the focus of a pencil of rays should be a point, it is evident that

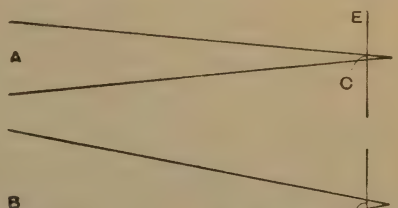


Diagram Showing, in Exaggerated Form, the Effect of Diameter of Aperture on Disc of Confusion

depth of focus is, strictly speaking, non-existent. In practice it is convenient to assume that an image composed of discs of confusion not more than ·01 in. in diameter is "sharp"; so that in this case the depth of definition is the distance before or behind the true focal plane between which the plate intercepts a cone of rays (of which the lens diaphragm is the base) at less than the diameter above named (·01 in.). It thus follows that the larger the working aperture the less the depth of definition, as indicated in the diagram, in which A is the cone of rays from a small aperture, B the cone from a larger one, and C and D the diameters of the discs of confusion respectively formed; the more acute the angle, the smaller is the disc. The surface of the sensitive film is indicated by the line E. By halving the diameter of the aperture the depth of definition is doubled, and so on in the same proportion. It also varies inversely as the square of the focal length of the lens for the same intensity, or inversely as the focal length for the same aperture. (*See also* "Hyperfocal Distance.")

DEPTH OF TONE

A term used, somewhat loosely, in pictorial photography to describe the lowness of the tone

values, and in technical photography to describe the extent to which a picture has been toned or developed. A print is said to be deep or low in tone when, generally intentionally, it has no brilliant high lights, and the appearance is dark or gloomy. Black or cold tones appear deeper than warmer ones; in other words, assuming a black-and-white bromide print to be cut into two, and one half toned to a brown, the brown, as a rule, does not appear so deep in tone as the black part. The depth to which a picture is toned or developed influences considerably the final result. As a consequence of toning gelatino-chloride (P.O.P) and other print-out papers, the tone becomes less deep, due to (*a*) the negative being flat, foggy, or otherwise unsuitable, (*b*) quick (or surface) toning, in which case the tone is on the top and easily taken off by the fixing bath, and (*c*) the use of a "hypo" bath in an acid condition. A black-and-white bromide print that is not fully developed will lose much of its depth of tone in a sulphide toning bath.

DEREPAS MOUNTING (*See* "Dry Mounting.")

DEROGY

A French optician of the 'fifties and early 'sixties. In 1859, he made public a half-plate convertible lens, with combinations fitting together by bayonet joints instead of the usual screws. Six changes were possible.

DESICCATED DRY PLATES

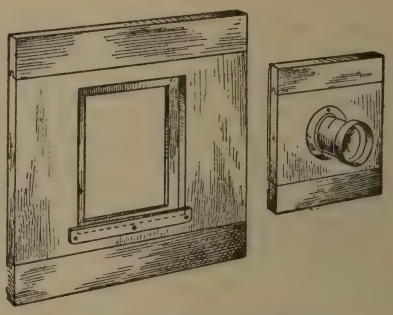
Dried, or heated, dry plates. It is well known that dry plates, as ordinarily used, retain a considerable percentage of water, mainly in molecular combination with the gelatine. Howard Farmer, to whom the idea of desiccated plates is due, found that the water has a large influence on the image at the time of exposure, definition, detail, density, speed, etc., being affected. He found, moreover, that very small differences in the percentages materially affect the result, so that negatives vary with the atmospheric conditions, as to temperature and humidity, at the time of exposure. According to Farmer, "The drier the film, the better the definition, and the greater the power of rendering fine detail; in lesser degree, the greater the speed and facility of developing density. This property of the film can be utilised by desiccating dry plates for work where definition, detail, brilliancy, or maximum speed are desired, and in exposing plates wet where softness of image or the destruction of small textures and details are sought for. Extra rapid and orthochromatic plates, in which the former of these qualities is usually found lacking, gain them when desiccated to an extent hitherto only found in wet collodion or other specially prepared films."

A perfectly flat-topped kettle containing boiling water is a convenient appliance for desiccating plates; these are simply laid film side upwards on the kettle top with a piece of bibulous paper between to equalise the heating, and kept there for a few minutes at a temperature of 200° F. (about 93° C.) before being placed in the dark-slides. Or a thick copper slab with an asbestos cover can be used. Too great or too prolonged heating will crack the dry plate or induce fog. Desiccation must be carried out in a dark-room, and the plates should be exposed while hot or as soon after the treatment as possible.

In process work, desiccated dry plates have been recommended for direct colour work.

DETACHABLE FRONT (Fr., *Planchette se détachant;* Ger., *Objektivbrett*)

A panel holding the lens and made to slip into a rebated opening in the camera front, in which it is secured by turn-buttons. It may be either square or circular. Any number of lenses, of different sizes, can thus be used on



Square Detachable Front

the same camera, a separate front being provided for each lens. For temporary use with a strange lens, when a panel is not forthcoming, a piece of stout cardboard may be cut to fit the opening in the camera front, a circular aperture being made in this to fit tightly on the lens. The inner side of the cardboard should be blackened.

DETAIL (Fr., *Détail;* Ger., *Einzelheit*)

The clear rendering of detail is largely dependent on focusing, and the defining power of the lens. A tree may be so rendered as to appear as a more or less homogeneous mass, or so as to indicate its leafy detail. The degree to which detail should be shown depends upon circumstances; in some cases the most minute details require to be clearly shown, and in others such a rendering is far from satisfactory. Suppression of detail results in the quality known as "breadth," but over-suppression leads to a loss of "texture." For example, a wicker-work basket showing every detail clearly would probably look hard and "fidgety"; on the other hand, the detail might be so suppressed as to make it difficult to recognise that the basket was of wicker-work at all. The direction and strength of the light and the state of the atmosphere are important considerations.

DETECTIVE CAMERA (Fr., *Chambre détective;* Ger., *Detectiv-Kamera*)

A term that appears to have been invented by T. Bolas, who in 1881 described a twin-lens magazine hand camera with focusing adjustment and pneumatic release, and having a reversing prism placed before the lens, so that the apparatus need not be directed at the person to be taken, who would remain quite unsuspicious of being photographed. Later, the name was applied loosely and inappropriately

to all box-form magazine hand cameras, which are still so designated in France. Practically the only cameras likely to be of real service in the detection of crime are those which are either entirely disguised, or are worked from a distance by the aid of a telephotographic lens. (*See also* "Disguising the Camera.")

DETERIORATION

Lenses, chemicals, and sensitive plates and papers all deteriorate more or less according to the length of time and manner in which they are kept. The commonest form of lens deterioration is due to the gradual depolishing of the glass surface by dust, the action being assisted by the careless or rough use of the dusting cloth. It is better to remove dust by blowing it off, but if wiping is necessary it must be done carefully (*see* "Lenses, Cleaning"). Sometimes when a lens is put on one side for a time an iridescence spreads over its surface, due to dampness. Lenses stored in a strong light often become slower in action, because of the yellowing action of light upon the balsam with which the lens glasses are cemented together.

Dry plates and sensitive papers deteriorate very quickly if not properly stored in a dry, airy place, the worst place being a high shelf where gas fumes can get to them. The effect of age on a plate much resembles that of a very slight exposure to light; but dry plates keep remarkably well if stored carefully, and skilled workers can frequently get good results on plates as old as twenty years.

J. B. B. Wellington in 1905 pointed out that the popular sulphide toning bath has a deteriorating effect upon plates and papers; everyone knows that the minute quantities of sulphur contained in a London fog will tarnish silver articles, producing upon them a thin film of silver sulphide, and that the sulphur in coal gas has the same effect when the gas is burnt. It is thus easy to understand how much more deleterious must be the large quantities of sulphur given off from the sulphurising bath of sodium sulphide on the still more delicate silver bromide and silver chloride which go to make up the emulsions coated upon plates, films, papers, etc. When these are kept in a room in which sodium sulphide is employed, they will become unusable in the course of a few weeks. Plates affected by sulphur will develop with an iridescent stain, with general deterioration and fog. Bromide and gaslight papers are affected in practically the same way, producing a flat and dirty print. With P.O.P. the surface will assume a metallic lustre, and when printed will be difficult to tone. Self-toning papers appear to discolour more quickly than other papers, but frequently this defect disappears in fixing.

DEVELOPER (Fr., *Révélateur*; Ger., *Entwickler*)

Any agent used to render visible the latent image, or, in other words, to reduce to silver or other metal the latent image produced by the action of light upon any sensitive salt. In ordinary photographic phraseology the term is applied to the solutions generally; whereas strictly speaking it should be applied only to that chemical or agent which actually reduces the exposed silver salt.

The composition of the developing solutions varies considerably not only with each make of plates, but frequently with each worker; but there is a definite quantity of developing agent which should at least be used, and this is undoubtedly largely dependent on the number of molecules in the active group, and the amido groups are more active than the hydroxyl groups. Von Hübl has given the following table based on this fact, which shows the best concentration of the actual developing agent and also the strength usually employed, assuming that a 5 per cent. solution of potassium carbonate is used as the alkali.

	Weight in every 100 parts of developer	
	Calculated	*Generally used*
Metol	0·6	0·6
Pyrocatechin	0·6	0·6
Hydroquinone	0·6	0·5—1·0
Amidol	0·4	0·4—0·8
Paramidophenol	0·5	0·4—0·7
Pyrogallol	0·5	0·3—0·6
Eikonogen	0·9	0·8—1·5
Adurol	1·0	1·0
Diogen	1·2	1·2
Glycine	0·5—1·7	1·0

The calculated quantities will give the maximum rapidity of development.

	I	II	III	IV	V	VI	VII	VIII
Pyrocatechin + caustic soda	15	100	0·6	5	10	20	slight	0·3
Metol + potassium carbonate	20	75	0·8	5	10	0	very slight	0·5
Hydroquinone + caustic potash	25	60	1·0	110	105	70	slight	0·4
Amidol	30	50	0·4	50	60	5	considerable	—
Adurol + potassium carbonate	30	50	0·6	30	45	25	considerable	0·6
Paramidophenol + potassium carbonate	40	38	0·5	70	30	30	considerable	0·5
Rodinal	40	38	0·5	45	40	30	slight	0·9
Pyro + potassium carbonate	40	38	0·5	35	55	40	considerable	0·3
Glycine + caustic soda	45	33	0·6	90	70	125	slight	0·8
Eikonogen + potassium carbonate	50	30	0·5	85	55	80	slight	0·6
Pyrocatechin + potassium carbonate	60	25	0·5	140	60	70	very considerable	0·6
Hydroquinone + potassium carbonate	70	21	0·7	95	80	120	slight	0·4
Diphenal	75	20	0·8	30	80	25	slight	0·7
Glycine + potassium carbonate	75	20	0·5	210	130	115	very considerable	1·0
Ferrous oxalate	75	20	0·5	280	90	80	slight	0·8
Diogen + potassium carbonate	95	16	0·4	115	120	80	considerable	0·7

A second table, also due to Von Hübl, is that at the foot of the preceding page. In column I. is given the duration of development to yield a certain density, in column II. the relative rapidity of development, in column III. the relative density-giving power, in column IV. the slowing of development in seconds by the addition of 2 per cent. of potassium bromide, in column V. the retardation in seconds due to cooling the developer to 50° F., in column VI. the retardation in seconds by diluting with an equal volume of water, in column VII. the action of bromide on the density, and in column VIII. the keeping power of the mixed developer, 1 being taken as that which keeps longest.

A developing solution should contain a certain quantity of alkali to form the actual developing salt or to increase the reducing power of the developer proper; and for this reason it is called the accelerator. A preservative is required to prevent too rapid oxidation or the deposition of an organic stain due to the oxidation of the developing agent.

The alkalis generally used are sodium carbonate, potassium carbonate, and caustic soda and caustic potash. Some alkalis act better than others with given agents, and on the European Continent potassium carbonate is generally used, whilst in England the corresponding sodium salt is used. The preservative is usually sodium sulphite, whilst potassium metabisulphite is occasionally used also. Only a few years ago an alkaline bromide was recommended in almost all cases, but this was partly due to the fact that the plates then did not work quite free from fog. Of late years the use of bromide has become much less general. Formulæ for the various developing agents are given under the respective chemicals.

DEVELOPER, VISCOUS

(*See* "Viscous Developer.")

DEVELOPERS, COMPARATIVE COST OF

The prices given below are approximate for each working quart (40 oz.) of developer at normal strength as prepared for pouring upon the exposed plate. The chemicals are taken at British retail prices.

	s.	d.
Adurol (one solution)	1	0
Adurol (two solutions)	1	3
Amidol	0	6½
Edinol	1	8
Eikonogen (one solution)	0	9
Eikonogen (two solutions)	1	3
Ferrous oxalate	0	5
Glycine (one solution)	0	7
Glycine (two solutions)	0	10
Hydroquinone	0	5¾
Hydroquinone-metol	0	7½
Imogen sulphite	0	5½
Kachin (one solution)	0	11
Kachin (two solutions)	1	0
Metol	0	10
Ortol	1	1
Pyro-soda	0	5
Pyro-metol	0	6
Pyrocatechin (one solution)	0	4
Pyrocatechin (two solutions)	0	9
Rodinal	0	7

Metol-hydroquinone, according to one maker's formula, costs 10d. per quart, and according to another maker's only 5½d. In actual practice, and on the basis of developing a fixed number of plates, there is not much difference, as many of the more expensive solutions are capable of treating a far greater number of plates than the cheaper ones, bulk for bulk.

DEVELOPERS, MIXED OR COMBINED

Mixed developers—as, for example, hydroquinone and metol—have become popular. Developers are of two distinct kinds: (1) those that give detail quickly and density afterwards; these include metol, rodinal, etc; (2) those that give density first and detail gradually—for example, hydroquinone and pyro. Taking one of each class and blending, it is possible to obtain a combination of characteristics; thus metol with hydroquinone gives detail without excessive thinness of the image or duration of development. The most is obtained with a combined developer by compounding it from one having a low factor number (*see* "Development, Factorial") with one of a high factor; and while most developers may be mixed together, there is no advantage in combining two developers of practically the same factor numbers, as, for instance, pyro and hydroquinone, both of which may be said to have, roughly, the factor of 6. A better combination is hydroquinone (factor 6) and metol (factor 30).

The best known and most widely used combinations are hydroquinone and metol, and pyro and metol, but the following have also their advocates: Metol-adurol, hydroquinone-eikonogen, hydroquinone-pyrocatechin, hydroquinone-rodinal, hydroquinone-amidol, metol-glycin, and others. Formulæ for some of the best known mixtures are:—

Hydroquinone-Metol

Metol	33 grs.	3·4 g.
Sodium sulphite	99 ,,	10·2 ,,
Hydroquinone	40 ,,	4 ,,
Potassium carbonate	198 ,,	20 ,,
Water to	20 oz.	1,000 ccs.

The above is a one-solution developer, ready for use. (*See also* "Metol-Hydroquinone.")

Pyro-Metol

A.	Pyrogallic acid	55 grs.	5·5 g.
	Metol	45 ,,	4·5 ,,
	Potassium metabisulphite	120 ,,	12 ,,
	Potassium bromide	20 ,,	2 ,,
	Water (boiled) to	20 oz.	1,000 ccs.
B.	Sodium carbonate (crystals)	4 oz.	200 g.
	Water (boiled) to	20 ,,	1,000 ccs.

Use equal parts of A and B.

Eikonogen-Hydroquinone

A.	Hydroquinone	40 grs.	4 g.
	Eikonogen	120 ,,	12 ,,
	Sodium sulphite	1 oz.	50 ,,
	Citric acid	20 grs.	2 ,,
	Water to	20 oz.	1,000 ccs.
B.	Sodium carbonate	60 grs.	6 g.
	Sodium hydrate	32 ,,	3·2 ,,
	Potassium bromide	6 ,,	·6 ,,
	Water to	20 oz.	1,000 ccs.

Mix A and B in equal parts.

Metol-Glycine

Glycine	50 grs.	5 g.
Metol	10 ,,	1 ,,
Sodium sulphite	2½ oz.	125 ,,
Potassium carbonate	2½ ,,	125 ,,
Water to	20 ,,	1,000 ccs.

One solution, ready for use.

Edinol-Hydroquinone

Water to	20 oz.	1,000 ccs.
Acetone sulphite	75 grs.	7·5 g.
Sodium sulphite	1 oz.	50 ,,
Edinol	30 grs.	3 ,,
Hydroquinone	15 ,,	1·5 ,,
Potassium carbonate	2 oz.	100 ,,

Dissolve in the order named, and for over-exposure add one drop of a 10 per cent. solution of potassium bromide to each ounce of developer used. The above is a one-solution, ready for use.

Hydroquinone-Rodinal

A.	Hydroquinone	120 grs.	13·6 g.
	Sodium sulphite	1 oz.	54·5 ,,
	Citric acid	5 grs.	·5 ,,
	Potassium bromide	60 ,,	6·8 ,,
	Water to	20 oz.	1,000 ccs.
B.	Potassium carbonate	2 ,,	100 g.
	Rodinal	1 ,,	50 ,,
	Water to	20 ,,	1,000 ccs.

For soft negatives use equal parts of A and B and water. For brilliant and harder negatives use equal parts of A and B without water. For detail increase the proportion of B, and for density increase that of A.

Pyro-Amidol

Sodium sulphite	198 grs.	20 g.
Sodium carbonate	66 ,,	6·6 ,,
Pyrogallic acid	20 ,,	2 ,,
Amidol	10 ,,	1 ,,
Water to	20 oz.	1,000 ccs.

Add the amidol just before developer is required, and it will be ready for use. It will not keep.

Adurol-Metol

Metol	118 grs.	13·5 g.
Adurol	410 ,,	47 ,,
Sodium sulphite	7 oz.	383 ,,
Potassium carbonate	4·7 ,,	256 ,,
Potassium bromide	21 grs.	2·4 ,,
Water to	20 oz.	1,000 ccs.

Dissolve the chemicals in the water in the order named. To develop plates add 1 part of the above to 2 parts of water.

Pyro-Hydroquinone

This is a mixed developer sometimes advocated, but both agents being slow-acting and somewhat alike, it is not particularly advantageous. It is included here chiefly because of the boric acid in the formula :—

A.	Hydroquinone	8 grs.	·8 g.
	Pyrogallic acid	80 ,,	8 ,,
	Potassium metabisulphite	80 ,,	8 ,,
	Boric acid (crystals)	10 ,,	1 ,,
	Water	20 oz.	1,000 ccs.
B.	Sodium sulphite	1 ,,	50 g.
	Sodium carbonate	1 ,,	50 ,,
	Water	20 ,,	1,000 ccs.

The boric acid is used as a restrainer because of its remarkable corrective power in cases of over-exposure.

A mixture of hydroquinone and eikonogen was introduced in 1892 under the name of "Mixtol." The formula is :—

Sodium sulphite	924 grs.	92 g.
Hydroquinone	115 ,,	11·5 ,,
Eikonogen	77 ,,	7·7 ,,
Potass. ferricyanide	154 ,,	15·5 ,,
Potassium carbonate	577 ,,	57·7 ,,
Caustic potash	115 ,,	11·5 ,,
Potassium bromide	8 ,,	·8 ,,
Boiling water	18 oz.	1,000 ccs.
Glycerine to	5 mins.	5 ,,

Mix in the order named, allowing each to dissolve before adding the next. The solution is of a yellowish colour, and keeps well. For "instantaneous" work, add one-half water; for time exposures, two-thirds, or omit the caustic potash and increase the carbonate to 700 grs., and add more bromide if necessary. It may be used over and over again, and it is claimed not to stain or frill.

A mixture of rodinal, hydroquinone, and eikonogen, known as "Cyclol," was at one time popular. The formula is :—

Eikonogen	100 grs.	10 g.
Hydroquinone	30 ,,	3 ,,
Rodinal	9 drms.	·9 ,,
Sodium sulphite	2½ oz.	125 ,,
Potassium carbonate	2½ ,,	125 ,,
Water to	20 ,,	1,000 ccs.

The above is a stock solution. For use in warm weather, 1 part is mixed with 7 parts of water; in cold weather, less water is used; and in very cold weather, only 3 parts of water.

Two developers are sometimes used separately instead of mixing, but they have no advantages over the combined developers given above. Detail is first secured with a quick-working developer and density afterwards obtained with a slower-working one. The following is an example: Develop with rodinal of ordinary developing strength until all detail has been brought out; then finish with ordinary pyro-soda developer, or preferably with the following one-solution mixture of hydroquinone :—

Hydroquinone	120 grs.	12 g.
Sodium sulphite	1 oz.	50 ,,
Potassium carbonate	1¾ ,,	88 ,,
Water to	20 ,,	1,000 ccs.

DEVELOPING

This article will be devoted to a simple explanation of the ordinary method and practice of developing a dry plate. The exposure having been made, the closed dark-slide is removed to the dark-room, and the plate developed either at once or at any convenient time afterwards. The work must be done in a safe light. In front of the lamp place a cleaned earthenware developing dish of the required size, and near it a glass measure containing about 2 oz. of the developer. Into another dish pour some fixing solution, made by dissolving 4 oz. of sodium hyposulphite ("hypo") in 20 oz. of water.

As all photographic solutions work more slowly when cold, it is advisable to mix up all solutions some time before they are needed, as when freshly mixed they are very cold, particularly the "hypo" solution, which drops almost to freezing point when newly mixed. By standing some time, the solutions become of the same temperature as the room. Anything between 65° and 70° F. (18° and 21° C.) is the best for developing and fixing solutions.

The beginner is recommended to use the hydroquinone-metol developer (*see* "Developers, Mixed"), and he should be informed that each chemical in the formula plays its own part. Hydroquinone and metol are the developers proper; but they need the help of the other ingredients. Hydroquinone gives density, and metol detail; so by combining the two, density and detail are obtained at the same time. The sodium sulphite is included to preserve the solution, and is called the preservative. The sodium carbonate or potassium carbonate quickens the developing action, and is called the accelerator. Potassium bromide is frequently added, and this controls the action, and keeps the negative clear. As each has its own characteristic action, it will be obvious that were the chemicals in separate solutions, they could be so adapted, if necessary, to suit under- or over-exposure; but there is no need to trouble with separate solutions. A good mixture is given below:

Hydroquinone . .	30 grs.	7 g.
Metol . . .	10 ,,	2·3 ,,
Sodium sulphite .	350 ,,	80 ,,
Sodium carbonate .	350 ,,	80 ,,
Potassium bromide .	5 ,,	1·15 ,,
Water to . . .	10 oz.	1,000 ccs.

Take particular care that no stray light enters the room, and that the only illumination comes from the red lamp. Remove the exposed plate from the slide and look at it, but not too near the lamp. Nothing on it will be seen; it will appear exactly as it did before the exposure. The image is latent (that is, concealed or hidden), and it needs to be brought out by the developer. Put the plate in the developing dish, the sensitive or creamy side of the plate being upwards and the glass side resting on the bottom of the dish. Then pour the developer over the plate in one quick sweep, so that the plate is completely covered in one sharp even flow, preferably from one corner. If the developer is properly applied, no air bubbles will form; but should any appear, break them quickly by touching them gently with the finger-tip, or, preferably, with a clean camel-hair brush. Then rock the dish from side to side and end to end, so that the developer flows evenly over the entire plate, taking care to expose it to the red light as little as possible. The brightest parts of the resultant picture, such as the sky, white collars, and white dresses, etc., will appear first of all. If the exposure is a landscape the sky will be the first to appear; but it will be black, as all lights and shades are reversed in a negative, the black or very dark parts of the actual scene appearing as almost clear glass and the whites almost or quite opaque. After the sky, the half-tones of the pictures will appear, and finally the details in the shadows. The developing dish must be gently rocked all the time. When the image has appeared, the plate must not be removed, but development continued for some little time longer, so as to add density to the negative. Continue for about a minute or so after the density appears to be correct, as this will be considerably reduced in the fixing bath.

It is important to know how long to continue development, and some experiments at the cost of a few plates will teach more than will many pages of printed matter. A negative that is taken out of the developer too soon is very thin, and will not give a good, clear picture; whereas a negative that has been left in the developer too long will be dense or harsh. As a general rule, when the negative is sufficiently developed, the dark parts in the negative, such as the sky, will show through the negative, and can be seen when the plate is examined from the glass side. The plate may also be taken out of the developer once or twice, and examined by holding it up to the red lamp, and its density judged by looking through it.

In cases of under-exposure, the image comes up very slowly, or only the high lights appear and not the half-tones and shadows. Development should be complete in ten minutes or even less. If after, say, fifteen minutes nothing, or very little, appears on the plate, try breathing on it, or warm the developer, but only very little, or the film will melt. If after a long time nothing appears, the plate may be destroyed as being useless. On the other hand, if the image appears extremely quickly, and the plate goes black all over in a minute or two, the plate has been over-exposed, or fogged by light other than that through the lens. A little extra potassium bromide added to the developer will sometimes save over-exposed plates if it is known that they are over-exposed before the developer is poured on; but after development has started it is a waste of time to add the bromide.

Subsequent processes, assuming that all has gone well, include a minute's rinsing in cold water, and transference, film uppermost, to the fixing bath, in which the plate remains for a period twice as long as that occupied by the whiteness in disappearing. Thus, if the whiteness disappears in ten minutes, allow the negative to remain for a further ten minutes. (*See also* "Fixing.") Finally, the negative, which may now be brought out into the daylight, is washed for at least thirty minutes in running water (*see also* "Washing"), while it stands on edge.

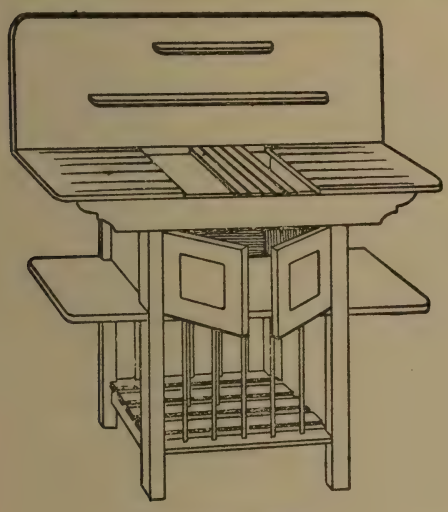
The beginner is recommended to adopt the factorial system of development. (*See* "Development, Factorial.")

DEVELOPING AFTER FIXING (*See* "Fixing before Development.")

DEVELOPING BENCH OR SINK (Fr., *Etabli de développement*; Ger., *Entwicklungsbank*)

A bench or table specially designed for developing, and usually provided with a stoneware or leaden sink. The top, if of wood, should be coated with shellac or other waterproof varnish. The height should be such that the operator can work at it without either stooping or straining, and there is no reason why it should not

be low enough for the worker to sit at, if this is desired. The continuous standing customary is merely fatiguing, and in no sense necessary. A very slight slope to the sides of the bench, so that spilt solutions may run into the sink, is useful; but this is often much overdone, so that bottles are liable to be upset, and the contents of full dishes to escape over one side. The developing bench may be either fixed or portable, but the essential features are practically



Developing Bench

the same in each case. A typical portable bench is illustrated. The sides are grooved so as to drain into the sink, which is of vitrified stoneware. The water is supplied by a swing-arm rose tap, under which may be placed a loose grid to hold dishes, etc. Convenient shelves for bottles, and racks for dishes, are fitted.

DEVELOPING DISH (*See* "Baths.")

DEVELOPING FILMS (*See* "Developing Machine," "Film Developing, etc.")

DEVELOPING AND FIXING COMBINED

A system of developing in which a sufficient amount of "hypo" is mixed with the developer in order that developing and fixing may be performed at the same time, a method thought much of at one time but little used nowadays. The secret of successful work is in the use of the correct amount of "hypo" to balance the developer. The "hypo" may be mixed separately and added to a developer, or made up in the developer itself. For the latter method edinol is perhaps the most suitable :—

Sodium hyposulphite	150 grs.	26 g.
Sodium carbonate .	¾ oz.	62·5 ,,
Sodium sulphite .	300 grs.	52 ,,
Edinol . . .	¼ oz.	21 ,,

Dissolve the first three in 12 oz. of water, add the edinol, and use at once. The former method is to make up the "hypo" and developer proper separately and mix before use, as follows :—

Ordinary developer .	5 oz.	150 ccs.
Sodium hyposulphite sol. (20%)		2 or 3 drops

The following developer is one that is popular upon the Continent, and works well with "hypo" :—

Hydroquinone . .	60 grs.	8·5 g.
Metol . . .	30 ,,	4·3 ,,
Sodium sulphite .	450 ,,	64·5 ,,
Sodium carbonate .	600 ,,	85 ,,
Water to . . .	16 oz.	1,000 ccs.

The "hypo" solution is added in the proportions stated above immediately before use.

If properly mixed, development is completed at the time the plate is fixed, and the negative simply requires the usual washing. The method forms an interesting experiment, but is not recommended for valuable exposures, as with some plates it does not always work so well as could be wished. "Hypo" also acts as an accelerator with some developers. (*See* "Hypo in Developer.")

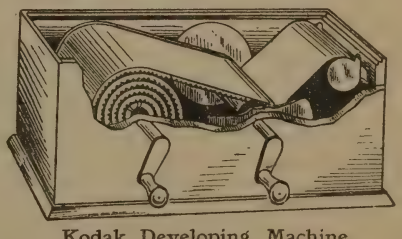
Kachin is one of the most suitable developers for combination with "hypo." J. McIntosh advocates the following :—

A.	Kachin . .	60 grs.	15·5 g.
	Sodium sulphite .	600 ,,	155 ,,
	Water to . .	8 oz.	1,000 ccs.
B.	Caustic soda .	40 grs.	18 g.
	Water to . .	5 oz.	1,000 ccs.
C.	Sodium hyposulphite . .	1 oz.	500 g.
	Water to . .	2 ,,	1,000 ccs.

For use take of A 160 minims, B 240 minims, C 20 minims, and water to make 1 oz.

DEVELOPING MACHINE (Fr., *Machine de développement;* Ger., *Entwicklungsmaschine*)

Various machines have been devised from time to time for the semi-automatic development of plates or films. One of the most successful for films was introduced in 1903 by Kodak, Ltd., and may be worked in full daylight. The spool of film having been inserted in the machine and the lid closed, a handle is turned which winds the film face outwards against a coiled "apron" of celluloid, with ribbed rubber edges acting as separators between the layers



Kodak Developing Machine

of film. The developer is then introduced and the film slowly rotated for a given time. It may next be washed and fixed in the same way and removed from the machine. Development takes from four to eight minutes, according to the temperature. In a later pattern of the machine (*see* illustration), the film having been wound into the red celluloid apron, is placed

in an upright cylindrical tank, and left for a specified time in a dilute developer. A waterproof lid to the tank allows it to be reversed at intervals during development.

DEVELOPING TANK (Fr., *Réservoir de développement, Cuvette hermétique;* Ger., *Entwicklungsbehälter*)

A metal or stoneware tank intended for stand or time development. There are many different patterns for both plates and films. In the Watkins developing tank a metal rack, holding one dozen plates, is attached to the lid in such a way that when inserted in the tank the plates are horizontal; the advantage is that one or two plates only can be developed if desired, with but a small quantity of solution. The plates having been inserted in the dark-room, and the closely-fitting lid adjusted in position, the developer is poured in at a light-trapped delivery piece projecting at one end of the tank. This delivery piece serves not only for the admission and discharge of the various solutions, which may be done in daylight, but can be used to hold a thermometer to give the temperature of the developer and the consequent time of development. Another typical developing tank is Griffin's, in which the solutions are poured through a light-trapped funnel and run off by a tap at the side. A chain is attached to the tank by which it may be hung under a tap for washing the negatives after development.

Tanks for "stand" development, in which the negatives are left for a long time in a dilute developer, consist usually of a grooved stoneware trough with a lid; these require a dark-room for the different operations. (*See also* "Developing Machine.")

DEVELOPING TENT (Fr., *Tente de développement;* Ger., *Entwicklungszelt*)

A portable folding tent for development out-doors, or in any place where no dark-room is available. In the wet-plate period every photographer was obliged to carry a dark-tent with him, as the plate had to be sensitised directly before use and developed immediately after exposure. The few peripatetic ferrotype workers still remaining use a similar contrivance. Small portable developing or changing tents are often a great convenience to travellers and tourists.

DEVELOPMENT, CONFINED

A system of development advocated in 1898 by Colson, a Frenchman, but now rarely used. The principle was to restrict the amount of developer in contact with the plate. The latter was placed in the developer in the usual way; but suspended over it and nearly, if not quite, touching it was a sheet of plain glass; or the exposed plate was soaked in water, and the plain glass in the developer, and the two placed in contact, repeating the process as often as necessary. Colson claimed that less fog and clearer negatives were produced in this way. The process was recommended for over-exposed plates, the first of the methods above noted being employed.

DEVELOPMENT, DAYLIGHT (*See* "Daylight Development.")

DEVELOPMENT, FACTORIAL

A system of determining the duration of development by noting the time of appearance of the first trace of an image on the plate and multiplying this time by a factor, the result being the total duration of development required to produce a negative of given density. This method was suggested by Alfred Watkins in 1893, and has been found in practice to be very reliable except in a few cases of exceptionally low temperatures and very dilute developers. It may be looked upon as one of the first practical steps to reduce development from mere happy-go-lucky guesswork to a definite and exact method. Like all methods based on laws it is elastic and capable of adjustment to the individual worker's ideas of what is a correct negative; or, in other words, by reducing or increasing the factor a thinner or denser negative may be obtained suited to the particular printing process employed. It is an ingenious application of Hurter and Driffield's law of constant density ratios, and is based on the fact that with correct exposure the total duration of development for a given density bears a fixed ratio to the time of appearance of the image, assuming that the developing power of the solution remains constant, and this rule holds good for variations in strength of the developing agent, in the amount of the alkali, bromide, and temperature.

The following factors are those generally used for the principal developers:—

Adurol	5
Azol	30
Certinal	30
Cristoid pyrocatechin	30
Diogen	12
Edinol	20
Eikonogen	9
Glycine-potash	12
Glycine-soda	8
Hydroquinone + bromide	5
Imogen sulphite	6
Kachin	10
Kodak powder	18
Mequin	12
Metol	30
Metol-hydroquinone	14
Ortol	10
Paramidophenol	16
Pyrocatechin	10
Pyro-metol (Imperial Standard)	9
Pyro-soda	·4–15
Quinomet	30
Rodinal	30
Synthol	30

PYRO-SODA AND PYRO-POTASH FACTORS

Pyro Grs. per oz.	*Bromide* Grs. per oz.	*Factor*
1	¼	9
2	½	5
3	¾	4½
4	1	4
8	2	3¼
1	0	18
2	0	12
3	0	10
4	0	8
5	0	6½

Factors for soft, normal, and strong contrasts with "tabloid" formulæ (Burroughs and Wellcome):—

	Soft	*Normal*	*Strong*
Amidol	7	10	12
Edinol	14	20	24
Eikonogen	8	12	15
Glycine	9	13	16
Hydroquinone	3	4½	5
Metol	20	30	35
Metol-hydroquinone	10	14	16
Paramidophenol	12	16	18
Pyro	4	6	7
Pyro-metol	6	9	11

The factor for a combined developer with the developing agents in equal quantities is the mean of the two, for example:—

Pyro 6 Metol 30
$(6 + 30) \div 2 = 18$

If the agents are not in equal proportions the factor for each is multiplied by the number of parts and the results added together and divided by the total number of parts of both agents; thus, supposing that the proportions were pyro 4 parts and metol 2 parts, it would be—

$6 \times 4 = 24$
$30 \times 2 = 60$
$60 + 24 = 84 \div 6 = 14$, the factor required.

The above factors are given merely as guides, and those that have been found to give a negative of normal contrasts, that is, one with a $\gamma = 1$, but should the worker think that such a negative is too soft or too hard, he has merely to increase or decrease the factor to obtain greater or less contrasts. Supposing one were using a metol-hydroquinone developer with a factor of 15, and the time of appearance were 9 seconds, the total duration of development would be $15 \times 9 = 135$ seconds.

The great advantage of the factorial system is that it gives the beginner an excellent idea of how long to develop and enables even the advanced worker always to obtain negatives of similar character.

DEVELOPMENT, FACTORS FOR (*See* "Development, Factorial.")

DEVELOPMENT, FORCING

When a plate is under-exposed, many workers add more of the alkaline solution to the developer, and continue the development until the plate begins to fog, or until it is considered impossible to secure more detail. Although by this method of forcing development the utmost shadow detail is secured, it has the disadvantage of making the light tones much too strong and dense; and the result is a harsh negative, excepting in the case of subjects deficient in contrast, for which subjects this method is satisfactory. For all others, a better plan is to take the negative from the developer, let it rest in plain water for about five minutes, and then continue development in a considerably diluted solution containing a large proportion of alkali. The dilute solution is thought to yield much softer contrasts.

DEVELOPMENT PAPERS

The opposite to print-out papers; they are papers on which the image is brought out by development after exposure. The principal and most widely used development papers are those known as bromide and gaslight papers, described fully under separate headings. Phosphate paper is also a development paper, and in some cases this is sold under fancy names. The above are development papers proper. Carbon is in a sense a development paper as the image cannot be seen until the exposed tissue has been washed in hot water. Platinum, ferro-prussiate, and the ferric papers are usually referred to as partial development papers, because the image shows very faintly after exposure, and needs development in order to bring it to its full strength.

In the United States, the term "development paper" is applied exclusively to gaslight paper.

DEVELOPMENT, STAND (Fr. *Développement dans les cuvettes verticales;* Ger., *Standentwickelung*)

This term was applied by Meydenbauer in 1892 to a system of developing plates in upright grooved tanks in extremely dilute developers, though the system was first described by Wratten and Wainwright in 1882. It is claimed for this process that the grain of the silver image is much finer than by any other method, that the gradations are truer and the results more uniform; in addition to which no visual examination is required, and therefore the plates are freer from fog. On the other hand, unless the developer be occasionally agitated there is considerable risk of peculiar local markings and stains. For many years after its reintroduction by Meydenbauer, extremely dilute solutions were recommended so that the duration of development was prolonged even up to twenty-four hours. Recently, however, a more sane view of the matter has been accepted, and time has been so considerably reduced that it has now practically been merged into "time development." (*See* "Development, Time.")

It is often considered that the necessary increase in the duration of development is calculable from the dilution—that is to say, if a normal developer takes three minutes to obtain a certain density, it will, when diluted ten times, require $3 \times 10 = 30$ minutes; this statement is not borne out by careful photometric measurements, and Wratten and Wainwright have published certain researches on the subject based on such measurements which disprove this assumption. They point out that stand development cannot be considered economical, as most of the commercial tanks require far too much developer; with 29 oz. for six half-plates, after half an hour's development the solution is so oxidized as to be useless. The idea that a plate may be left in a stand developer for an indefinite time is also wrong; as is also the theory that a plate which should require only thirty minutes will be as much spoilt in an hour as the same plate developed for six minutes instead of three. It is as important, therefore, to know the correct duration of stand development as that of ordinary development. They further point out that the increase of time

required with rodinal is largely dependent upon the amount of air dissolved in the water to make the developer. For instance, a plate that required three minutes' development with 1 : 20 rodinal required forty-two minutes when developed with 1: 200 rodinal diluted with air-free distilled water, and not thirty minutes; forty-six minutes with ordinary distilled water, and fifty-two minutes with ordinary tap water. Pyro-soda and glycine are not dependent on the amount of air in the developer, but a ten times diluted pyro developer requires fifteen times the length of development with the strong developer.

Edge markings are very liable to occur, due to the plates being too near to the edges and the bottom of the tank, and thus being starved of developer. Plates are also as liable to chemical fog in stand development as in any other kind, and therefore too prolonged development should be avoided or bromide should be added to the developer, in which case the exposure must be increased, and not the duration of development. Zinc tanks should be avoided, as they are very liable to be attacked by alkalis.

DEVELOPMENT, THEORY OF

The old theory of development was that the reducing agent or developer reduced the exposed silver bromide or latent image to metallic silver, and that the bromine combined with the alkali to form an alkaline bromide, and this is usually expressed by the following equation :—

$$AgBr + DNa = Ag + Na\,Br + D$$

in which D merely stands for the developing agent. This was satisfactory as far as it went, but it really explains very little. The later theories, which involve a consideration of the ionic theory, assume that when a salt is dissolved in water it is split up into so-called ions, which are considered to be atoms of the elements carrying an electric charge. Metallic or basic ions are usually termed kations, and the acid ions are termed anions, the former carrying a positive and the latter a negative charge. Chemical reactions are now considered to take place between ions, and only when the substance goes into solution, and thus becomes dissociated or ionised. According to this we might represent the formation of silver bromide by the following equation :—

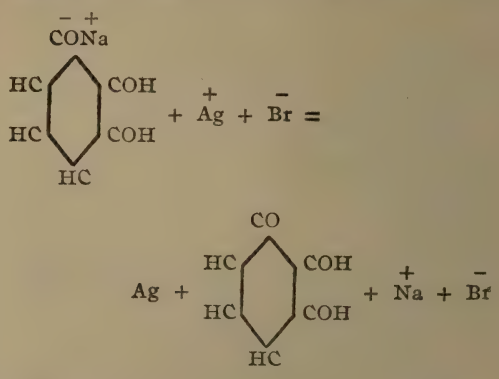
$$K^{+} + Br^{-} + Ag^{+} + NO_3^{-} = Ag^{+}Br^{-} + K^{+} + NO_3^{-}$$

which roughly shows the dissociation of potassium bromide into the potassion K carrying a + or positive charge, and bromion carrying a − or negative charge, silver nitrate being dissociated into positive Ag + and negative nitrion NO_3 − then the final result would be :—

$$K^{+}Br^{-} + Ag^{+}NO_3^{-} = AgBr + KNO_3$$

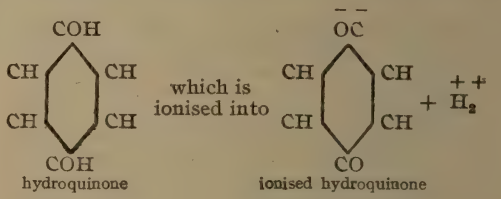
and as a positive and negative charge meet in AgBr this becomes unionised, and is precipitated as an insoluble precipitate.

If now we apply this to development, and we assume the formation of an alkaline phenolate, as in the case of pyrogallol with only sufficient caustic soda to form this, we might represent the action as follows :—

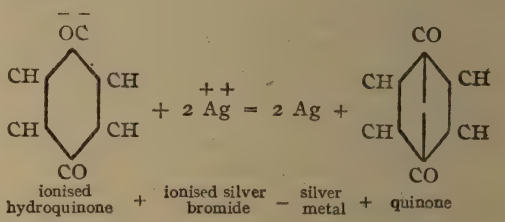


That is to say, the pyrogallol loses a negative charge which neutralises the charge on the silver ion. No account is here taken of any change in the pyro, though such must take place, but the oxidation products are not well known.

In the case of hydroquinone, however, where we know that the product formed from it in development is quinone, we can simply write the equation as follows :—



then



and the ionised hydroquinone has merely lost two negative charges which neutralise the positive charges of the silver in the ionised silver bromide, and the two oxygen ions combine to form quinone.

Obviously there are certain physical phenomena which one must take into consideration, and an emulsion consists of a number of particles of silver bromide embedded in a jelly. The modern theory of a jelly is that it consists of a number of minute cells with passages in between ramifying in all directions, and the cells and passages contain a weak solution of gelatine, whilst the cell walls are formed of a very strong solution. In each cell we may imagine a grain or particle of silver bromide, and for the developer to reach this it is obvious that it must first

traverse the passages, and then diffuse through the cell walls. The first is termed macro-diffusion, which takes place at a rapid rate, and the later action, which is comparatively slow, is known as micro-diffusion. It has already been pointed out that a chemical reaction can only occur when the silver bromide goes into solution and is ionised into + Ag and − Br. The instant the developer reaches the dissolved silver it is reduced to the metallic state and deposited, provided there be some nucleus or germ on which it can deposit. This nucleus is the latent image (*which see*). Were there no nucleus, then the silver would accumulate in solution till super-saturation occurred, and then the chemical action would cease. As soon as the dissolved silver is deposited, fresh silver takes its place, and so the process proceeds till the whole of the silver available is reduced.

In the above rough sketch of what is supposed to take place, we must not lose sight of the important fact that, as pointed out in the note on the latent image (*which see*), Scheffer has proved that the action of light is to cause the protrusion of filaments or threads from the sensitive salt grain, and therefore these would rupture the cell walls, and so render the access of the developing agent much easier.

Now, if we consider what happens when a plate is developed, we shall at once see that at first we shall have some silver halide grains, which are so affected by light as to be readily reduced by the developer, and some which are not affected. As development proceeds we shall have (*a*) some grains already reduced to metallic silver, (*b*) others not yet completely reduced, and (*c*) others which are not light-affected and therefore not attackable by the developer. Naturally, at first the progress of development will be rapid, as the whole of the light-affected grains will be capable of development, but as it proceeds there will be fewer and fewer of the (*b*) grains, so that development gradually gets slower and slower, and we may express this by saying that: the rate of increase of density = constant (maximum density attainable − density obtained).

Here the constant or velocity constant is usually termed K.

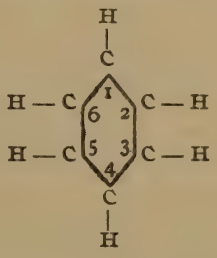
If the temperature of the developer be raised then the velocity constant, or K, increases, and this is termed the temperature coefficient, which is generally defined as the ratio for correct development at 10° C. (50° F.) difference of temperature.

The efficiency of a developer E is the velocity of development compared with ferrous oxalate at 20° C., divided by R, which is the reducing power, or the number of grain-molecules of AgBr reduced by one grain-molecule of the developing agent. The energy F is the concentration of bromide producing the same retardation of development as with ferrous oxalate for 0·01 *n* potassium bromide. For a complete mathematical treatment of the subject, the reader is referred to "Theory of the Photographic Process," by Sheppard and Mees.

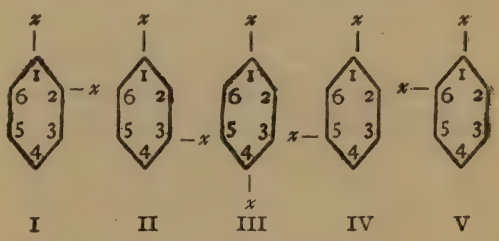
Before leaving this subject it would be as well to consider the question of the chemical constitution of the actual developers or reducing agents.

Of late years the number of developers has been largely increased, and a glance at their true chemical names will at once prove that they are highly complex organic substances belonging to the benzole or naphthalene series.

Benzene or benzole has the formula C_6H_6, but in 1865 Kekulé, from a long series of experiments, came to the conclusion that the six atoms of carbon in benzene form a closed-chain or nucleus, and that the molecule of benzene is symmetrical, and that each carbon atom is directly united with one, and only one, atom of hydrogen. The graphic formula usually adopted is as follows:—



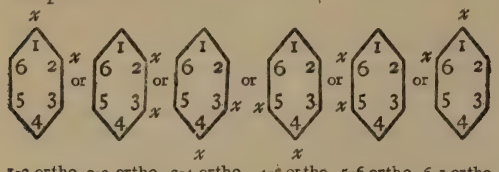
Now, in the above formula it is obvious that if two of the six hydrogen atoms were replaced by two other atoms or groups they might be arranged in one of five different ways, as shown in the accompanying diagrams, in which, for the sake of clearness, the C atoms are omitted and the added group or atom expressed by *x*.



Then, if one *x* group occupies any given position, that numbered 1, for instance, the other may occupy 2, 3, 4, 5, or 6. But these five formulæ only represent three isomeric compounds, that is, compounds of the same composition $C_6H_4x_2$, and not five, because it is obvious that IV. and V. are practically identical with I. and II., which may be at once seen by writing them on thin paper and looking at them first in the normal way and then through the paper. In order to distinguish these three compounds, they are said to be in the ortho, meta, and para positions:—

Now, obviously in the ortho position the two *x* groups are joined to carbon atoms which are directly united or are next to one another, so

that we could actually represent an ortho compound as

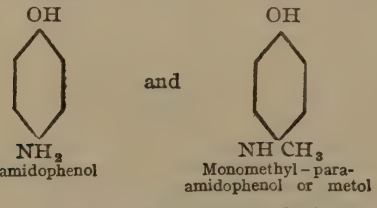


1-2 ortho 2-3 ortho 3-4 ortho 4-5 ortho 5-6 ortho 6-1 ortho

Exactly in the same way, the meta compounds could be represented by placing x x at 1—3, 2—4, 3—5, 4—6, 5—1 and the para at 1—4, 2—5, or 3—6 positions.

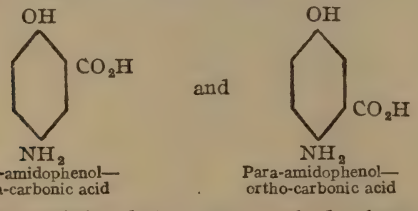
Now, it has been proved by Lumière and Seyewetz and by Andresen that a developer must have two hydroxyl OH groups or two amido NH_2 groups joined to the benzole ring, and that these groups must be either in the ortho or para positions to be developers. The latter compounds are the stronger developers, the ortho compounds the weaker, whilst the meta compounds are not developers at all. If one of the hydrogen atoms of a hydroxyl group be replaced by an alkyl radicle—that is, an alcohol radicle, such as ethyl C_2H_5—or by another radicle, then the developing power is destroyed, as, for instance, in phenetroin

If, on the other hand, one of the hydrogen atoms of an amido group be replaced by an alkyl radicle, then the developing power is increased, as in the case of



Para-amidophenol and Monomethyl-para-amidophenol or metol

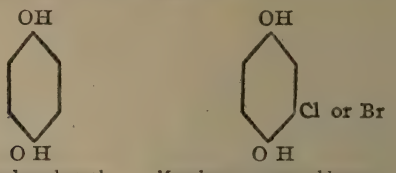
Besides the OH and NH_2 groups, the hydrogen atoms of the benzole ring may be replaced by other radicles, such as carboxyl COOH, and the sulpho group SO_3H, but these reduce the developing power, and in this case the position of the added or substituted radicle plays an important part, as in the instance of



Para-amidophenol—meta-carbonic acid and Para-amidophenol—ortho-carbonic acid

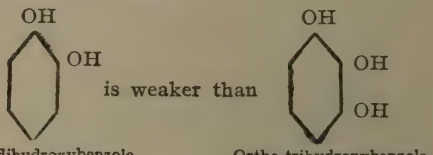
the former being but a very weak developer, whilst the latter is a vigorous one.

If a hydrogen atom be replaced by one of the halide atoms Cl or Br, then the developing power is increased, as in the case of



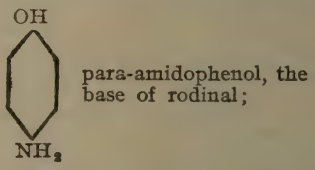
Para-dihydroxybenzole or hydroquinone; Monobrom or monochlor-para-dihydroxybenzole or adurol

If three hydrogen atoms in the benzole ring are replaced by three NH_2 or OH groups, then the developing power is increased, and here, as in the case of the di-substitution products, the ortho-, meta-, or para position plays an important part, thus

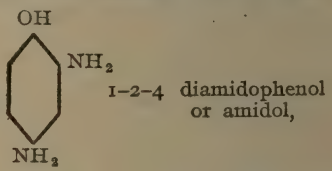


Ortho-dihydroxybenzole or pyrocatechin; Ortho-trihydroxybenzole or pyrogallol

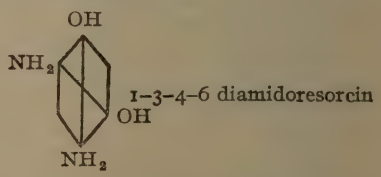
because in the former there are only two OH groups in the ortho position, whilst in the latter there are three OH groups all in the ortho position. Again, if one OH and one NH_2 group be added to the ring, then we have a still more energetic developer, as in the case of



whilst the addition of another NH_2 group increases the action still further, as in the case of



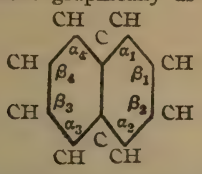
which is at once an ortho- and a para-amidophenol, and diamidoresorcin



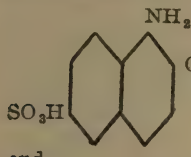
a double para-amidophenol, in which the OH and NH_2 groups, as shown by the lines, are in two para positions; this is still more energetic.

There are two developing agents which belong to the naphthalene $C_{10}H_8$ series, and naphthalene may be considered as two benzene rings joined together, and which at the points of junction

have lost their hydrogen atoms, so that we may write naphthalene graphically as

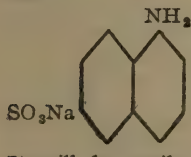


Here, too, the hydrogen atoms may be replaced by other atoms or groups, and we have



α_1 amido-, β_1 naphthol-, β_3 sulphonic acid or eikonogen,

and



α_1 amido-, β_1 naphthol-, β_2 β_3 acid sulphonate of soda or diogen.

It will be easily seen that the Greek letters and the numbers refer to the positions of linking of the substituted atoms. In the above sketch the developing bases only have been considered, for many of the actual developers are salts, such as chlorides, sulphates, oxalates, etc., of these bases.

DEVELOPMENT, THERMO

A name invented by Alfred Watkins for a system of developing in which the duration of development is varied as the temperature of the developer varies, to distinguish it from "time development" pure and simple. Although it had been known for a long time that development was prolonged in cold solutions, Houdaille in 1903 was one of the first to suggest a definite rule, in conjunction with hydroquinone, to the effect that a variation in temperature of the developing solutions of 1° C. caused a variation of 5 per cent. in the time of appearance of the image and the duration of development. In 1905 Ferguson and Howard published a method of obtaining a given gamma or degree of contrast with a developer of constant composition at varying temperatures by developing strips of a plate exposed behind a sector wheel for different times, measuring the gammas obtained and plotting them on a chart. Later, Ferguson suggested a simpler method, in which only two strips were developed for given times and the temperature coefficient of the developer found by a very simple logarithmic calculation. The objection to both these methods is that a sector wheel and photometer are required. As, however, Ferguson's method is simple, and the basis of that to be described later, it is briefly given here.

The first thing to determine is what is known as the temperature coefficient of the developer used, or the increase in velocity of development for a rise of 10° in temperature, from which the increase in rapidity of development for 1° can be found by dividing the logarithm of the temperature coefficient by 10. The usual mathematical expression for the temperature coefficient is—

$$\frac{\text{velocity at } (t + 10°) \text{ C.}}{\text{velocity at } t° \text{ C.}} = b^{10};$$

therefore b, or the increase for 1°, is—

$$\frac{\text{log. of temperature coefficient}}{10} = \text{log. } b.$$

Ferguson has suggested that two strips of a plate should be exposed to the same graduated series of light and one developed at $t°$ C. and the other at $t° + x°$ C.; then the times required to obtain the same gamma or degree of contrast on each plate will be M and m, and as the times are inversely proportional to the velocities

$$\text{log. } b = \frac{\text{log. } M - \text{log. } m}{x}$$

in which b = the temperature coefficient for 1° C., and 10 log. b will be the temperature coefficient for 10° C.

To make this quite clear two strips of a plate should be developed so as to show the same degree of contrast, one at a given temperature and the other at this temperature plus a certain number of degrees. Two strips A and B of a plate were exposed to the same graded series of light, and A took 3½ minutes to obtain a gamma = 1 at 10° C. and B took 2½ minutes at 18° C., then—

$$\begin{aligned} \text{log. } 3{\cdot}5 &= {\cdot}5441 \\ \text{log. } 2{\cdot}5 &= {\cdot}3979 \\ &\overline{\quad\quad} \\ &{\cdot}1462 \end{aligned}$$

Now the difference of temperature (△ as it is usually written) was 18 — 10 = 8°

$$\therefore \quad {\cdot}1462 \div 8 = {\cdot}0182 = \text{log. } b$$

$\therefore$ 10 log. b = ·0182 × 10 = ·182 = the temperature coefficient for the plate and developer used. Having found the above, to find the necessary duration of development at 14° C. to obtain the same gamma the formula is—

$$\text{log. } M - x \text{ log. } b = \text{log. } m$$

or, in words, from the logarithm of the time required at 10° C. subtract 14 — 10 = 4 times log. b, and the result will be the logarithm of the time required; assuming that log. b = ·0182 as above, then—

$$\begin{aligned} \text{log. } 3{\cdot}5 &= {\cdot}5441 \\ 4 \text{ log. } b = {\cdot}0182 \times 4 &= {\cdot}0728 \\ &\overline{\quad\quad} \\ &{\cdot}4713 = \text{log. of } 2{\cdot}96 \end{aligned}$$

minutes, the time required.

Watkins has done away with the sector wheel or graded series of lights and the finding of the gammas; he merely exposes a plate on a landscape including some sky and cuts it in two, or makes two exposures. It is essential to have some means for warming up the developer, dish, and measure, and also to have a thermometer. When the developer, dish and measure are warmed up, say to 75° F. (about 24° C.) the plate is placed in the dish and flooded with the developer, the time accurately noted, and the first appearance of any image also noted; the plate being now of no further use it may be thrown away. The second half of the plate is now developed in a developer of exactly similar composition, only colder, the time of appearance

noted, and we have all the factors necessary for finding the time of development for any temperature with that particular plate and developer if we know also the factorial number (*see* "Development, Factorial") of that developer. Suppose, for example, that a metol-hydroquinone developer with a factor of 15 is being used, and it is found that at 50° F. (10° C.) the first appearance of the image takes place in 40 seconds and at 66° F. (18·8° C.), the first appearance takes place in 28 seconds; then turning to a table of logarithms we find that log. 40 = 1·602060 and log. 28 = 1·447158, then—

1·602060 — 1·447158 = 0·154902.

Now the difference in temperature is 66 — 50 = 16, then 0·154902 ÷ 16 = ·009681 = log. of 28·3 seconds, and as the factor for this developer was 15, then 28·3 × 15 = 424 seconds = 7 minutes practically, which is the time required to develop the plate at 57° F. (14° C.).

It is obvious from this that we can calculate a table for every degree (or two degrees will be enough) rise or fall in temperature of the developer, by multiplying the log. factor by 2 and adding for every two degrees drop or subtracting in the case of a rise, and then multiplying the number by the factorial number. This may seem somewhat complicated, but the logarithms have merely to be read from a mathematical table-book and simple division, multiplication, and subtraction performed.

DEVELOPMENT, TIME

Practically, this method of development was established upon a sound basis by the researches of Hurter and Driffield, who proved that it was only necessary to reduce or increase the duration or time of development in order to obtain negatives of any desired degree of contrast, and that it was not necessary to tinker with the constituents of the developer. The outcome of this work was the slow recognition of the fact that it was advisable to use a given developer at a given temperature for a given time to obtain a particular class of negative. This method is particularly valuable in the case of colour-sensitive plates, which may be immersed in the developer completely protected from light, and at the end of the stated time washed and fixed. (*See also* "Development, Thermo.")

DEVIATION (Fr., *Déviation;* Ger., *Abweichung*)

An optical term denoting the alteration in the course of a ray of light when bent from its original path by refraction or reflection. The length of a prismatic spectrum alters according

Deviation of Rays Passing Through Prism

to the position of the prism with reference to the rays of white light falling upon it ("incident rays"). When the prism is so placed that the spectrum is practically at its shortest length, which happens when the mean emerging rays (say the green, at the E Fraunhofer line) and the incident rays make the same angle with the prism, as shown in the illustration, the latter is said to be in the position of "minimum deviation."

DEXTRINE (Fr., *Dextrine;* Ger., *Dextrin*)

Known also as British gum. This white or yellowish-white powder, soluble in water, in which it forms a viscous and gummy solution, insoluble in alcohol and ether, has the formula $(C_6H_{10}O_5)_n$. The pure substance is made by submitting starch paste to the action of malt extract; after filtering, maltose is precipitated by repeated treatment with alcohol, and finally the dextrine is thrown out by adding sufficient absolute alcohol. It is also made by the action of heat or of nitric acid on potato starch. It has the same chemical composition as starch, but its properties are different. The principal use of dextrine is in the making of mountants (*which see*). There is a further variety, of a brown colour, but this is not used as a mountant.

In process work, dextrine has been advocated as an addition to the etching bath, the addition of gummy matter to the bath being claimed to facilitate etching and keep the etched surface bright. Dr. Albert has recommended a powder, which is believed to be a mixture of dextrine and powdered alum, for use with the nitric acid solution, to cause a frothing of the bath; the theory is that the solution is oxygenated and the hydrogen gas given off is absorbed.

DEXTROSE

Known also as glucose and grape sugar; a white crystalline solid, formula $C_6H_{12}O_6$, readily soluble in water. It has been recommended as an addition to mountants and as a preservative for plates, but is now rarely used. It is employed in some processes of silvering glass.

DIACTINIC (Fr., *Actinique;* Ger., *Aktinisch*)

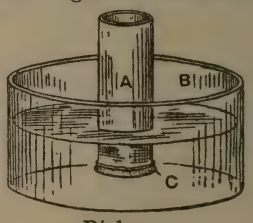
Capable of passing actinic or photographically active light; the opposite of non-actinic.

DIAGONALS OF PLATES (*See* "Sizes.")

DIAGRAMS AS LANTERN SLIDES. (*See* "Lantern Slides, Diagrammatic.")

DIALYSER

A parchment, skin, or paper stretched over the open end of a glass or wooden vessel, which



Dialyser

is then placed in an outer container of water (*see* illustration). Into the dialyser are poured liquids such as thin solutions of gelatine or other colloid containing salts, the latter diffusing

through the septum into the water, and leaving the gelatine or other colloid in the dialyser. In the illustration, A is the dialyser, B the outer vessel of water, and C the septum or skin.

DIAMIDOPHENOL (*See* "Amidol.")

DIAMIDOPHENOL HYDROCHLORIDE (*See* "Amidol.")

DIAMIDORESORCIN (Fr. and Ger., *Diamidoresorcin*)

C_6H_2 OH OH NH_2 HCl NH_2 HCl. Molecular weight, 153. Solubilities, soluble in water, more soluble in sodium sulphite solution. It is a complex organic salt, very similar in its action to amidol, and, like that, developing in the presence of sodium sulphite only. (*See also* "Diamine.")

DIAMINE

A form of diamidoresorcin (*which see*) introduced by Lumière as a developer. A formula is:—

Sodium sulphite (anhydrous) . .	250 grs.	30 g.
Diamidoresorcin	85 ,,	10 ,,
Water to . .	20 oz.	1.000 ccs.

DIAMOND LENS

In the early days of photographic optics experiments were made with every kind of transparent body which could be formed into a lens. Claudet had a small lens fashioned from a diamond, expecting much from the high refraction of this substance. However, it was not found to be of any practical value. It was destroyed in a fire at Claudet's Regent Street studio, London.

DIANOL

Lumière's preparation of oxalate of diamidophenol or amidol (*which see*), which is claimed to be rather more soluble than the hydrochloride, the usual salt employed.

DIAPHAN, AND DIAPHANOTYPE

An obsolete process used for obtaining transparent pictures for viewing in a diaphanoscope. Diaphan pictures were upon paper, and diaphanotypes upon glass, but the terms were often reversed, and in the end all the pictures were known as diaphanotypes. The process as advocated by Thomas Sutton (published December 15, 1856) was as follows: "Thin photographic paper must be employed. Immerse for half an hour in a solution of 20 grs. ammonium chloride; hang up and dry. Sensitise by floating on a bath of nitrate of silver, containing 50 grs. of nitrate to 1 oz. of water; hang up in the dark to dry. In printing, apply the back of the paper to the negative and print through the paper very deeply. In this way the silver in the heart of the paper becomes reduced. Wash well, and tone in a weak gold bath made by adding 15 grs. of gold chloride in 20 oz. of water to a solution of 50 grs. of hyposulphite of soda in another pint of water. Leave the print immersed till it is thoroughly toned, then fix it in one part hypo to ten parts of water. The hypo reddens it slightly, but it becomes perfectly black on drying. Wash as usual, dry, and wax." Sutton also advocated a development process for producing the pictures. Other workers made an ordinary paper print transparent with wax or Canada balsam, backing it up with a duplicate print, while others coloured their pictures. At the end of the diaphanotype "craze," the pictures resembled crystoleum pictures.

The terms were also applied at one time to lantern slides and window transparencies, both plain and coloured.

DIAPHANOSCOPE (Fr., *Diaphanoscope;* Ger., *Diaphanoskop*)

A contrivance, much resembling the alethoscope, pantoscope, or lanternoscope, intended for the exhibition of transparent positive photographs. It consists of an enclosed box, which may or may not be furnished with a lens, the pictures being placed inside at a distance from the eye preferably equal to the focal length of the lens with which the negative was obtained.

DIAPHRAGM SHUTTER (Fr., *Obturateur à diaphragme;* Ger., *Blende-verschluss*)

A shutter made to work between the two combinations of a compound lens—that is, against the diaphragm, and opening from and closing to the centre. It is obvious that the shutter itself acts as an expanding and contracting diaphragm, though not necessarily circular, and that consequently a large part of the exposure is practically given with a smaller aperture than that of the fixed diaphragm. The definition of the lens is thus improved, but the efficiency of the shutter (the relative proportion of the exposure during which it is fully open) is rather low. When of good quality, diaphragm shutters give excellent results. They are much used on the better-class hand cameras, and are usually so fitted as to form part of the lens mount. The exposures marked on cheap diaphragm shutters are seldom reliable.

DIAPHRAGMS (Fr., *Diaphragmes;* Ger., *Blenden*)

A diaphragm is the aperture, fixed or removable, used in front of a single lens and between the combinations of a double lens, generally referred to as the "stop." The various forms of diaphragms, systems of marking, values, etc., are as follow:—

Various Forms.—The three patterns in general use are known as "rotating," "Waterhouse," and "iris." Very cheap lenses, and those of obsolete patterns, are usually fitted with fixed stops, or pierced circles of metal which are let into the lens tube. Rotating stops are mostly fitted to wide-angle and landscape (single) lenses, and are employed in many hand cameras; a series of circular holes of various sizes are pierced round the margin of a revolving disc fitted to the lens mount. Waterhouse diaphragms were invented by John Waterhouse, of Halifax, in 1858, a circular aperture being cut in a thin piece of sheet metal and inserted into a slot in the lens mount, a separate piece—called a stop—being required for each opening. The "iris," the most modern form of diaphragm, consists of a series of curved plates of metal, vulcanite, or other material, fitted inside the lens tube and attached to a ring on the outside

of the lens mount; by revolving the ring the plates are made to open and close, thus forming apertures of various sizes. Some Continental lenses have other forms of stops, but they are rapidly falling into disuse. The form in which the diaphragm is made does not affect its action on the lens in the least, and optically one stop is as good as another; it is in the matter of convenience where one pattern has any advantage over another. The iris pattern—so named, by the way, because it opens and closes like the iris of the eye—is undoubtedly the most convenient and popular pattern.

Systems of Marking.—There are at least half a dozen systems of marking. Stops are marked with numbers, such numbers, as a rule, appearing upon the iris ring or lens mount when the iris system is used, upon the top or handle of a Waterhouse diaphragm, and upon the circular revolving disc in the case of rotating diaphragms; in the last-mentioned case the number appears opposite to the aperture which it indicates, so that when the stop is in use in the lens itself its number is visible outside the lens tubes. Included in the stop-marking systems in vogue are the "f," "U.S.," "Dallmeyer," "Goerz," "Zeiss," and "Voigtländer," besides many others. The "f" and "U.S." systems are adopted for all but 1 per cent. of the lenses in general use, and of these the former is the more popular, especially in England, it being in a sense self-explanatory. The "f" number simply means the proportion of the diameter of the stop to the focal length of the lens. For example, *f*/8 is of a diameter one-eighth the "focus" of the lens. The "f" value of an unnumbered stop can be ascertained by dividing the focal length of the lens by the diameter of the stop. For example, a 1-in. stop with a lens of 8-in. focal length is known as *f*/8; a $\frac{1}{2}$-in. stop with the same lens, *f*/16; a $\frac{1}{4}$-in. stop with the same lens, *f*/32, and so on. Thus the "f" number is not a fixed dimension, but always a relative one, varying with the lens employed; obviously *f*/8 with a 16-in. lens would mean a diameter of 2 in., whereas with an 8-in. lens it would mean a diameter of 1 in. Strictly, the "f" numbers should be $\frac{1}{8}$, $\frac{1}{11}$, $\frac{1}{16}$, etc., but the fractional form is ignored, and the numbers spoken of as 8, 11, 16, etc. Stops of definite "f" values may easily be cut to the required size. Suppose, for example, that with a lens of 6-in. focal length, an *f*/16 stop is required, then, 6 divided by 16 = $\frac{6}{16}$ = $\frac{3}{8}$; therefore, the stop must be $\frac{3}{8}$ in. in diameter.

While, in the above rough-and-ready system of measuring, the "f" value of a stop may be accurate enough in the cases of ordinary rapid rectilinear and single lenses, extreme accuracy is essential in the case of modern and improved anastigmat lenses; for while a slight error may be of little moment with a small stop, the same amount of error—which error is, of course, proportional to the aperture—becomes serious with large stops, which are a feature of anastigmat lenses. It is necessary in such cases to consider the *effective* aperture. The stops on a modern lens by a good maker are always correctly numbered, and it is only when a worker attempts to check the optician's calculations by dividing the focal length by the aperture that he finds an imaginary error. The division system described above leads to false conclusions when some modern anastigmat lenses are measured by it, because of the great condensing power of the lens in front of the stop, from which lens measurements are taken. To quote an example; one of the most expensive of anastigmat lenses has a stop the value of, and marked, *f*/8; but the aperture of the stop is one-ninth the focal length, and, according to the rough and ready rule given above, would be *f*/9; while the stop marked *f*/5, although accurate, is *f*/7 according to the division method. The following method of finding the effective aperture of a stop is more reliable with all kinds of lenses. The camera is set at "infinity," or a distant object is focused upon the ground glass. A piece of card is then put in the place of the ground glass, or pasted thereon, so as to entirely cover it. In the centre of the card, and on the spot exactly opposite the lens, is made a hole the size of a pin's head. The camera is then taken into the dark-room, and by the assistance of a ruby or orange light a disc of bromide paper is cut to fit the inside of the lens cap. The cap, with the sensitive paper inside it, is then placed on the lens in the usual way, the sensitive side towards the stop. A lighted candle is then held against the hole in the cardboard for about half a minute, so that the light may travel through the camera, lens and stop to the bromide paper. The latter, after exposure, is taken out and developed, when a circular black spot will be found thereon, and the diameter of this spot will be the effective diameter of the stop used. If the exposure is made with the largest stop, the developed spot gives the effective aperture at which the lens will work, and the focal length of the lens divided by this, the true aperture, gives the "f" number.

Opticians have adopted standard "f" numbers, namely, 3·16, 5·66, 8, 11·3, 16, 22·6, 32, 45, and 64, but stops may be "in between" any of those named, or larger or smaller than 3·16 and 64 respectively. As a general rule, 11·3 is spoken of as 11 and 22·6 as 22, but in the case of larger stops the decimal point, when it occurs, is always mentioned, as, for example, 4·5, 5·8, 6·8, etc.

The "U.S." system (now practically obsolete in England) has long been popular in the United States, for which reason the initials are looked upon as indicating that country. Such, however, is not the case. "U.S." stands for "uniform system," as an attempt was made, first of all in 1881, by the Royal Photographic Society to induce all lens makers to adopt a uniform system of marking diaphragms.

The Royal Photographic Society's standards and recommendations (dated 1901) are as follow:—(1) That intensity ratio be defined as dependent upon the *effective aperture* (and not upon the diameter of the diaphragm) in relation to the focal length of the lens. (2) That effective aperture be determined in the following manner: The lens shall be focused for parallel rays; an opaque screen shall be placed in the principal focal plane, the screen being provided in its centre (in the axis of the lens) with a pinhole; an illuminant shall be placed immediately behind the pinhole and the diameter of

the beam of light emerging from the front surface of the lens shall be the measure of the effective aperture. *Note.*—It will be found, except when the diaphragm is situated in front of the lens, that the diameter of the diaphragm itself is seldom identical with the effective aperture. (3) That every diaphragm be marked with its true intensity ratio, as above defined, in the following order of sequence: *f*/4, *f*/5·6, *f*/8, *f*/11·3, *f*/16, *f*/22·6, *f*/32, *f*/45·2, *f*/64, etc., each diaphragm requiring double the exposure required by the preceding diaphragm. Should the greatest effective aperture of a lens not conform exactly to one of the intensities set forth above, this aperture should be marked in accordance with the definition of effective aperture, but all succeeding smaller apertures should be marked in uniformity with the above sequence.

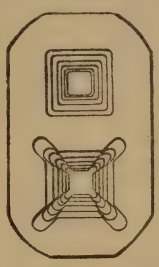
Stops marked by the Uniform System are commonly known as Nos. 1, 2, 4, 8, 16, 32, 64, 128, and 256; the respective "f" values are 4, 5·6, 8, 11, 16, 22, 32, 45, and 64.

Most of the lenses produced in France are marked according to the method advocated by the Paris Congress of 1889. *f*/10 is taken as the unit aperture, the series advancing as the "Uniform" system; No. 1 is *f*/10, No. 2 *f*/14, No. 4 *f*/20, and so on.

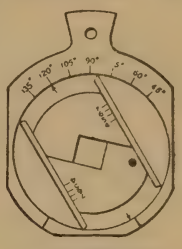
Influence of Diaphragms on "Rapidity."—The "rapidity" of a lens depends upon the stop used. The "U.S." numbers indicate relative exposures, but the "f" numbers do not, although the relative exposures are easily calculated from them. To find out the relative values of the "f" stops, first square them, and the exposure is then as one product is to the other. Thus, *f*/16, for example, requires four times the exposure necessary with *f*/8, because 16 × 16 = 256, which is four times 8 + 8 = 64. When makers mark their stops as follows, *f*/8, 11, 16, 22, 32, 45, and 64, each stop requires double the exposure of the preceding one and half that of the succeeding one.

The Use of Diaphragms.—The main functions performed by stops are as follow:—(1) They govern the definition. A large stop, such as that generally used for focusing, may produce an indistinct image upon the focusing screen or sensitive plate, and it may be necessary to insert smaller stops into the lens in order to secure better definition. If, say, an object a few feet from the camera is sharply focused with a large stop, the background and surroundings may not appear sharply defined. The insertion of a smaller stop serves to cut down the area of the base of the cone of light formed by the lens, and the result is increased definition (*see* "Depth of Definition"). (2) To correct functional errors (as covering power) in a lens. Lenses not of the modern and improved anastigmat pattern have certain optical errors which show themselves when very large stops are used, and many of the older and even modern common lenses do not yield a sharp image all over the plate, a defect that is corrected by the use of a small stop and consequent increase in exposure. (3) To add to, or subtract from, the number of planes in a picture. All views are composed of various planes, or distances. When a large stop is used, only one plane is in focus, and the smaller the stop the greater the number of planes made clear and sharp.

In process work, various forms of diaphragm apertures are used, with the object of promoting the dot formation. The principle is that the apertures in the ruled screen act as pinhole lenses and form an image of the diaphragm, so that in this way the shape of the dot image is controlled. The square diaphragm is most



A. Penrose Diaphragm System



B. Adjustable Diaphragm

commonly used, but squares with extended corners are also employed to promote the joining up of the dots in the high lights. The Penrose diaphragm system A standardises the use of such stops, the apertures being arranged on the basis that each smaller stop requires an exposure of half as much again compared with the next larger size. The adjustable diaphragm B enables any size of square opening to be formed.

DIAPOSITIVE

An old name for a lantern slide or similar transparency made to be viewed by transmitted light. The name differentiated transparencies from positives upon opaque supports as, for example, daguerreotypes, ferrotypes, and wet collodion pictures backed up with black material.

DIATOMS, PHOTOGRAPHING (*See* "Photomicrography.")

DIAZOTYPE

There are several printing processes based on the light-sensitiveness of the diazo compounds, which, although not much used, are of considerable interest, as they give a great range of colours. The diazo compounds are extremely rich in oxygen, and are formed by the action of nitrous acid on the aromatic amines, amidosulphonic acids, amidocarbonic acids, etc., and readily combine with certain phenols and amines to form azo dyes. If a paper or material impregnated with a diazo compound is exposed under a negative, the diazo compound is decomposed by the action of light, and on immersion in a solution which forms a dye with the diazo compound a negative image is obtained.

The primuline process invented by Green, Cross and Bevan in 1890 is based on the light-sensitiveness of the diazo compound of primuline, a yellow water-soluble dye which dyes material or paper without a mordant. Paper or material is immersed in a solution of:—

Primuline . .	320 grs.	33 g.
Hot water to . .	20 oz.	1,000 ccs.

and then washed and immersed in—

Sodium nitrite .	64 grs.	6·6 g.
Hydrochloric acid	150 mins.	15 ccs.
Water to . .	20 oz.	1,000 ,,

It should then be dried in the dark and exposed under a vigorous positive till those parts under the bare glass are colourless. Then wash thoroughly with water, and treat with one of the following solutions :—

For Red

β-Naphthol .	9·6 grs.	10 g.
Sodium hydrate	128 ,,	13·3 ,,
Water to . .	20 oz.	1,000 ccs.

For Orange

Resorcin . .	64 grs.	6·6 g.
Sodium hydrate	106 ,,	11 ,,
Water to . .	20 oz.	1,000 ccs.

For Purple

α-Naphthylamine	190 grs.	20 g.
Hydrochloric acid	1 oz.	50 ccs.
Water to . .	20 ,,	1,000 ,,

For Black

Eikonogen .	125 grs.	13 g.
Water to . .	20 oz.	1,000 ccs.

For Brown

Pyrogallol .	113 grs.	12 g.
Water to . .	20 oz.	1,000 ccs.

Wash well after development. Various coloured images can be obtained on the same print by local application of the above solutions with a brush. This process does not give pure whites.

Andresen suggested the following modification :—

Pyridine base (pure)	110 grs.	23 g.
Boiling water .	10 oz.	500 ccs.

then add—

Sulphuric acid (pure)	180 mins.	37·5 ccs.
Distilled water	180 ,,	37·5 ,,

Benzidine sulphate is formed, and partially separates out. Cool the solution down to 100° to 120° F. (38° to 49° C.), and add—

Sodium nitrite .	86 grs.	18 g.
Water . .	1 oz.	50 ccs.

in small quantities with continuous stirring. The benzidine sulphate is diazotised and dissolves. Filter the solution and pour into five times its volume of alcohol, which precipitates the diazo compound; filter out the precipitate, and dissolve (without drying, as it explodes when dry) in—

Distilled water to .	20 oz.	1,000 ccs.

The paper or material is sensitised in this cold solution by floating or immersion for two minutes, dried in the dark, and exposed under a positive, and then developed in a 2 per cent. solution of amidonaphthol sulphonic acid —5, or amidonaphtholsulphonic acid —9, containing 2 per cent. of sodium hydrate. Deep blue images with pure whites are thus obtained.

Feer's process uses aniline diazosulphonate, amidobenzols, etc., with phenolic alkalis, amines, and phenylamines, the following being typical sensitisers :—

1. Sodium toluoldiazosulphonate . 240 grs. 25 g.
   β-Naphthol . . 240 ,, 25 ,,
   Sodium hydrate . 76 ,, 8 ,,
   Distilled water to 20 oz. 1,000 ccs.
2. Sodium ditolyltetrazosulphonate . 240 grs. 25 g.
   μ-Phenylendiamin 190 ,, 20 ,,
   Distilled water to . 20 oz. 1,000 ccs.
3. Sodium ditolyltetrazosulphonate . 240 grs. 25 g.
   Resorcin . . 211 ,, 22 ,,
   Sodium hydrate . 154 ,, 16 ,,
   Distilled water to . 20 oz. 1,000 ccs.

The paper is immersed in these solutions, and after drying exposed for about five minutes to sunlight or electric light. On the exposed parts the insoluble azo dye is formed, whilst in the unexposed part the sensitiser remains colourless and washes out. The print should be fixed in hydrochloric acid.

Andresen discovered in 1894 another diazo printing process. The sensitiser is the diazo compound of α-naphthylamine or β-naphthylamine, the former giving brownish grey images and the latter brown-red. If the exposed paper is washed amd treated with tetrazo-diphenyl ether, violet images are obtained.

Distilled water . .	5 oz.	150 ccs.

heat to boiling, and add—

α- or β-Naphthylamine . . .	220 grs.	14·3 g.

then add—

Hydrochloric acid (sp. g. 1·19) . .	152 grs.	10 g.

and as soon as the salt has dissolved add—

Hydrochloric acid	617 grs.	40 g.

with constant stirring, and cool the paste down to 40° F. An evolution of gas takes place, and a yellowish solution is formed which must be filtered into an ice-cold dish. Float paper on this for fifteen seconds and dry in the dark. Expose for two or three minutes under a negative in the sun and develop in a 10 to 20 per cent. solution of twice fused acetate of soda, and wash well.

These processes give rather pleasing effects when applied to silks and other materials.

DI-CARBOXYLIC ACIDS (*See* "Carboxylic Acids.")

DICHROIC FOG (*See* "Fog.")

DICHROMATIC PHOTOGRAPHY

A process of colour photography invented by Gurtner, in which only two constituent colours, blue and orange-red, are used. Two plates are placed film to film, the nearest to the lens being coated with a transparent emulsion stained yellow; on this only the blue rays act, and on the rear plate, which must be panchromatic, the yellow, orange, and red rays act. From these

two negatives are made prints, in orange-red for the front plate and blue for the rear one, and superimposed. Obviously it cannot give pure reds or pure yellows, but merely for landscape work some pleasing results have been obtained.

The same principle is used by Smith and Urban in kinematography and with far greater success, because as the pictures are now projected very rapidly, and the observer sits in a darkened room, one is not sensible of the absence of any colour or the failure to make pure white.

DICYANINE (Fr. and Ger., *Dicyanin*)

Solubilities, soluble in water and alcohol. This is a complex aniline dye prepared by the action of an alcoholic solution of caustic potash on α- γ-dimethylchinoline salts with the aid of atmospheric oxygen. It forms greenish glittering crystals which dissolve in alcohol with a greenish-blue colour, and in water with a more reddish tinge, both solutions being decolorised by acids. It is one of the best sensitisers known for the extreme red, particularly for the region about λ 7,200, the range extending through the orange and yellow, but it gives a deep minimum or lack of sensitiveness between E and F in the green and green-blue, and is not therefore so much in use as some of the other dyes. It is very easily decomposed in weak solution, and therefore should only be added to the sensitising bath immediately before use. (*See also* "Colour Sensitising.")

DIETZLER

An optician of Vienna, chiefly noted for his manufacture of the orthoscopic lens designed by Prof. J. Petzval, which was first issued in 1858, although calculated as early as 1841. (*See* "Lenses, Orthoscopic.")

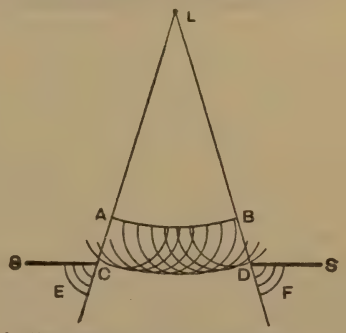
DIFFRACTION (Fr., *Diffraction;* Ger., *Diffraktion, Ablenkung, Beugung*)

When light passes through a very narrow slit it apparently bends round the edges and spreads out on both sides. The subject is fully gone into under the heading "Diffraction Grating."

In process work, a theory advanced in regard to the action of the ruled screen used for the half-tone process is that diffraction plays an important part, especially with the finer screens, and some authorities claim that advantage can be taken of this action to promote the better formation of the half-tone dot. Diffraction is said to produce the effect of larger or smaller dot images instead of only stronger or weaker ones, as would be the case if there were no action of deflected light.

DIFFRACTION GRATING (Fr., *Réseau de diffraction;* Ger., *Diffraktions-Gitter*)

An opaque screen containing a large number of fine slits, or a transparent screen having opaque lines engraved upon it very close together. A pencil of light is formed of a wave front or a series of overlapping waves which may be represented by the diagram A, in which L is the light source and A B the main wave front in which every particle excites fresh secondary waves, as shown by the curve C D. Nearly all these secondary circles mutually interfere one with the other, except in the main wave front C D. This interference cannot be seen, but its existence can be proved by limiting the size of the main wave front by an opaque screen S S, which stops out some of the secondary waves but not all, and the latter are seen as delicate fringes E F on each side of the main wave front. This can be experimentally proved in a very simple way. Take a black opaque card about 6 in. or 8 in. square, and cut in the centre a slit about 1 in. long and about ⅛ in. wide. Take also a piece of glass about 3 in. square and either smoke it or cover it with black varnish, and with a fine



A. Diagram showing Principle of Diffraction Grating

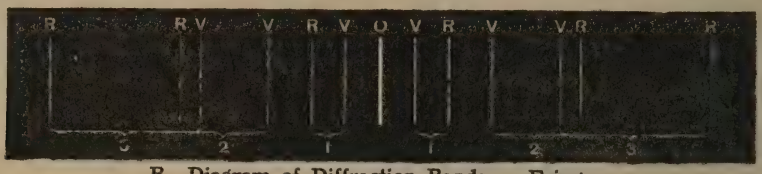
needle-point scratch a thin, clear line about ½ in. long. On holding the card at arm's length close to a brilliant light, and examining it through the scratch on the glass, held close to the eye, there will be seen a bright central image of the slit, and on each side of it faint black lines, which are the diffraction fringes. If in front of the light source a violet glass is placed and then a deep red one, there will be obtained images, as shown in the diagram B, in which O is the central image, V the violet bands or fringes, and R the red ones, the violet being nearer together than the red. If a green glass is used the green fringes would fall midway between the red and violet.

The explanation of this phenomenon is as follows: In diagram C let A B represent an opaque screen with an aperture C D, and L the beam of light, which, proceeding in a straight line, forms a bright central image at E F. Now diffraction, or the bending of the light waves round the edge of the opaque screen, will cause secondary waves to proceed in all directions from every particle of ether lying between C D. For the sake of clearness, let us consider only the waves in one direction, and represent these as straight lines C G D H. Let us further assume that between C and D there are eight ether particles acting as sources of secondary waves. If we now draw C W at right angles to the path of the rays, it will be at once seen that the waves from D have further to travel than those from C by the distance D W. Let D W be a wavelength, then obviously ½ D W is exactly half a wave length; drawing a perpendicular from ½ W to the ether particles we at once see that the wave from 4 is exactly half a wave length from C, and the same distance in front of that from D. By the same reasoning it will be found

that 1 is half a wave-length in front of 5, 2 half a wave-length in front of 6, and so on; so that every ray is in opposite phase with another ray in the slit. Now two rays in opposite phase (*see* " Interference of Light ") produce interference or darkness, so that on the screen G E H F there would be a dark band. By similar reasoning we could find beyond this particular angle a bright band where the secondary waves would be in the same phase.

It is obvious that the greater the number of apertures in an opaque screen the greater the number of secondary waves formed, and therefore the greater the chance of interference. Further than that, the narrower the slit the greater must be the obliquity or the angular distance from the central image, for the greater obliquity will be required to produce the neces sary difference between the paths of the rays from a narrower slit; that is to say, the more slits there are in a unit length the greater the obliquity. Now we have already seen that the violet bands are closer together than the red, and that the green would lie in between, so that if we illuminate a series of slits by hetereogeneous white light the waves will be sifted out into their respective positions, and we obtain a spectrum in which the rays are arranged according to their wave length.

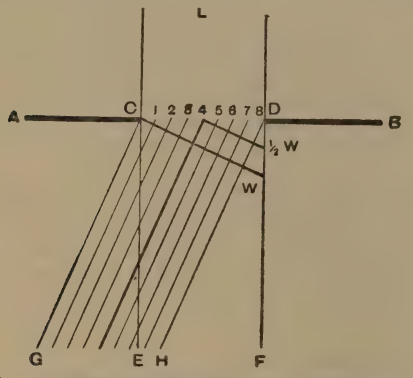
Fraunhofer was the first to utilise the phenomenon of diffraction, and he made his gratings of silver wire wound round two fine threaded screws placed some distance apart. The next forward step was the ruling of a series of fine lines with a diamond on glass, and later still the glass was silvered. Then Rutherford, of New York, ruled the lines on plane speculum metal, and later on spherical mirrors of speculum metal. Diffraction gratings on glass are called transmission gratings, as the light passes through them, the rulings acting as opaque screens; those on metal are known as reflection gratings. Diagram B represents practically the spectra which are obtained with any diffraction grating. They are arranged on each side of the central white image O. The spectra nearest O are called the spectra of the first order, then there is a dark space filled by the invisible infra red and the invisible ultra violet; then we have the spectra of the second order overlapped even in the visible spectrum by the violet of the third order. Then follow the fourth and other order spectra, the number being dependent on the brilliancy of the light and the character of the grating.



B. Diagram of Diffraction Bands or Fringes

A moment's consideration will prove that the spectra formed by a diffraction grating cannot be as brilliant as a prismatic spectrum, for although there is some loss of light with the latter, through the reflection from the front surface of the prism and by absorption in the glass itself, yet in the case of the diffraction grating not only does the bulk of the light proceed to the central image, which is useless, but the rest is split up into the various spectra on each side. Sometimes, too, in consequence of some peculiarity in the ruling, one or other of the spectra may be much more brilliant than the others.

A grating spectroscope or spectrograph is, however, much to be preferred to a prismatic, as the rays are arranged exactly according to their wave-length, whilst with the prismatic spectrum the violet and blue are spread out at the expense of the red and orange, which are cramped together. (*See also* " Spectrum," " Diffraction Grating Replicas," etc.)



C. Diagram showing Cause of Diffraction Bands

DIFFRACTION GRATING REPLICAS (Fr., *Replicas des réseaux de diffraction;* Ger., *Diffraktions-Gitter-Abklatsche*)

Original gratings, whether on glass or metal, are extremely expensive, and numerous attempts have been made by Rayleigh, Abney, and others to reproduce these by photographic means, but the most successful way is that of taking casts in celluloid. Thorpe, Ives, and Wallace produce these, and the latter has given full working instructions, of which the following is an abstract:—

Pyroxyline . .	18¾ grs.	3·9 g.
Pure amyl acetate .	1 oz.	100 ccs.

Add the pyroxyline in small quantities to the amyl acetate, shake well till dissolved, and allow to stand for twenty-four hours. At the end of that time the resultant collodion should be poured from a height of at least 3 ft. or 4 ft. in a very thin stream into a large tray filled with water, the latter being constantly stirred with a glass rod. In about twenty-four hours

the whole of the pyroxyline is precipitated in the form of white or light grey flocculent masses, which should be collected and dried. The purpose of this precipitation is probably to purify the pyroxyline, as any collodion poured into water gives up what Eder has called "pyroxyline gum." The particular pyroxyline recommended by Wallace is not obtainable in England, but Hopkins and Williams's high temperature pyroxyline gives excellent results, as does also Mawson and Swan's collodion when precipitated in this way. It is not necessary to use amyl acetate before the precipitation, the ordinary solvent of equal parts of alcohol and ether proving quite satisfactory, and the precipitation is instantaneous. When thoroughly dry the precipitated pyroxyline is again dissolved in the above proportions, and the collodion carefully filtered through paper. This, which is troublesome unless pressure is used, may be avoided by allowing the collodion to stand three or four days, when the whole of the impurities settle to the bottom of the bottle.

The grating should be carefully levelled in a drying cupboard, and this is absolutely essential to prevent the occurrence of dust; next, it is carefully dusted with a soft camel-hair brush, and the solution flowed over the surface. The exact quantity is a matter of experiment, too thin a film being difficult to handle whilst too thick a film gives a matt surface. About 1·5 ccs. is the right quantity to use for a 2-in. grating. The best method of applying the solution is with a fine pipette, which will hold just the necessary quantity. This enables one to distribute the solution over the surface without touching the grating itself, and the solution can be easily led to any part, or an air bubble brought to the edge and broken.

The coated grating should be left in the cupboard for at least twelve hours, and longer is preferable, even for three or four days; the longer it is left the easier it is to handle. To strip the cast, the grating should be placed in a dish of distilled water, when the edges will soon begin to show shadow bands. As soon as these are observed the grating should be taken from the dish, and any adherent water removed with a soft rag. Slight pressure with the thumb nail along one edge will cause the cast to spring from the metal, and it should then be grasped by a pair of wide-jawed forceps, as used in microscopy, and pulled off with a firm but even motion in a direction parallel to the lines of the ruling. The edges of the cast should be trimmed off, and it should then be lowered on to a piece of carefully cleaned and polished plate glass, which should be immersed in distilled water and lifted out with a small pool of water on its surface. One edge of the cast should be lowered on to the glass first, and then the rest gradually lowered so that it pushes the water in front of it without the occurrence of air bubbles. As soon as it is in position one edge should be clipped by a strong metal clip, and a piece of soft velvet rubber passed across it in the direction of the rulings; when contact is obtained everywhere the edges should be cemented down with some of the collodion as used for the cast. This can be applied with a very fine camel-hair brush. The cast may be cemented face up or face down, but with the latter there is less chance of the rulings being damaged. When the cast has been cemented it may be dried by heat, gentle at first, but gradually increased to 167° F. (75° C.). The chief cause of failure is dust particles between the glass and the replica. If the replica is mounted face down, another piece of glass may be cemented to the back.

There is some contraction of the cast in drying, but this is small. Wallace found that with a grating of 28·867 mm. width and 16,397 lines the shrinkage was 0·176 mm. on the entire width, or about six lines more to every one thousand. The shrinkage can, of course, be easily determined by accurate measurement of the original grating and the cast; thus, in the case referred to above, the original width = 28·867 mm., width of replica = 28·691 mm.; therefore with a total of 16,397 lines in the original, 568 lines = 1 mm. On the replica obviously 16,397 ÷ 28·691 = 572 per mm. This shrinkage simply causes greater dispersion of the spectrum.

When examined in a quartz spectrograph these replicas were found to transmit up to λ 2,613 in the ultra-violet, but obviously their glass support absorbs up to about λ 3,400. Prof. R. W. Wood has suggested the use of thin mica sheets, and naturally quartz could be used for the support. This process of taking casts from a grating in no way damages it, it being, in fact, an excellent method of cleaning a grating.

DIFFUSED LIGHT (Fr., *Lumière diffusée*; Ger., *Zerstreutes Licht*)

Light that is spread and softened by the interposition of any translucent medium, such as clouds, a misty atmosphere, a muslin screen, ground glass, opal, etc.; the opposite to direct light, coming unobstructed from the source of illumination. Printing in diffused light means printing in daylight other than direct sunshine.

Diffused light in the camera, tending to cause fog, is light that is reflected or scattered by the sides of the camera, etc.

DIFFUSING SCREEN (Fr., *Écran de diffusion*; Ger., *Verbreitungschirm*)

Synonyms, diffusion screen, diffuser. Any translucent material or fabric used to spread and soften light. Thus, a frame covered with tracing cloth, white muslin, or thin calico is employed in the studio to obtain a soft, round lighting. A circular diffusing screen is advisable in conjunction with the electric light for portraiture, as illustrated under the heading "Arc Lamp." A sheet of ground glass or opal is often used in enlarging by artificial light without a condenser, to distribute the illumination equally over the whole of the negative. The same method is frequently adopted in daylight enlarging, though an inclined white reflector is perhaps more usual. White tissue paper is sometimes pasted over the printing frame when a thin negative is required to print slowly. A piece of ground glass in the dark-room lamp, behind the ruby or orange glass, gives a more even and better distributed light.

DIFFUSION OF FOCUS

The soft effect obtained by throwing the image very slightly out of focus on the screen just before exposure, this producing "fuzziness."

DIHYDRIC PHENOLS

Derivatives of phenol or carbolic acid which contain another hydroxyl group, thus phenol or hydroxy-benzene is C_6H_5OH, the dihydric phenol $C_6H_4(OH)_2$. Catechol, resorcinol, and hydroquinone belong to this group, the last-named being of much photographic interest.

DILUTE DEVELOPMENT

A method in which very dilute developers are used, such as in stand development (*which see* under the heading "Development, Stand").

DIMINISHING GLASS

A double concave lens mounted in a holder and used for examining drawings or photographs which have to be reduced by photographic processes. By its use it is possible to judge somewhat the effect of reduction.

DINITRO-NAPHTHOL

$C_{10}H_5(NO_2)_2OH$. The sodium salt is known as Martius yellow, which is sometimes used for yellow filters. The sulphonic potassium salt is known as naphthol yellow.

DIOGEN (Fr. and Ger., *Diogen*)

Solubilities, soluble in cold water, insoluble in alcohol and ether. The acid sodium salt of α_1 amido-, β_1 naphthol-, β_2 β_3 disulphonic acid, introduced in 1897 as a developer. It freely dissolves in alkaline sulphite and carbonate solutions, giving a yellowish coloured developer, which is readily amenable to the influence of a bromide.

DIOPTICHROME PROCESS (*See* "Dufay Dioptichrome Process")

DIOPTRICS

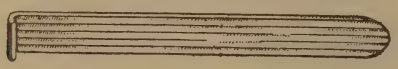
The department of optics referring to the laws governing rays of light passing through transparent media, as air, water, glass, crystal, etc.

DIPHENAL (Fr. and Ger., *Diphenal*)

$C_6H_3OHNH_2$ $C_6H_4NH_2$. Molecular weight, 200. Solubilities, almost insoluble in cold water, very soluble in hot water; soluble in alcohol and glacial acetic acid. It must be kept in a well-stoppered bottle. It is a highly concentrated solution of the phenolate of diamido-oxydiphenyl in caustic alkaline solution, and was introduced in 1897 as a developer.

DIPPER (Fr., *Crochet;* Ger., *Küvettenhaken, Silberhaken, Plattenheber*)

A kind of holder employed in the wet collodion process, to immerse the plate in the silver bath. It may be of glass, porcelain, ebonite, or silver wire, and is furnished with hooks or



A. Fluted Glass Dipper

projections at the bottom to hold the plate. Those of fluted glass A, though somewhat liable to breakage, are perhaps the cleanliest.

In process work, where the dipper is important for the wet-plate process commonly worked, various forms have been adopted. The usual styles are the fluted glass A and ebonite B. The forked dipper C is an American idea, the object being to support large plates more firmly than do the usual narrow dippers. Another kind of dipper is made of hickory wood; by pressing the handle parts together the forks move apart

B. Ebonite Dipper

C. Forked Dipper

and allow the plate to be inserted. On releasing the pressure the forks press the plate between them, so that there is no chance of dropping it. A coat of shellac varnish makes the wood waterproof. A similar arrangement can be used as a developing holder. Silver wire or silver plate can be bent to the shape of a dipper, but becomes expensive in large sizes.

DIPPING BATH (Fr., *Cuvette verticale à bain d'argent;* Ger., *Kuvette*)

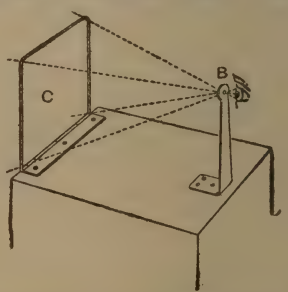
The upright vessel of ebonite, glass, etc., for containing the silver bath in the wet-plate process. Those made of white glass are preferable.

DIPPING-BATH DEVELOPMENT

An early form of what is known as stand development. It was advocated in 1892 by a German, Dr. A. Meydenbauer, who described it under the name of "Standentwickelung." Its principle is found in the prolonged action of a very diluted developer contained in a dipping-bath. The early name "dipping-bath development" has been superseded by "stand development"; for full particulars, *see* "Developing Tank" and "Development, Stand."

DIRECT FINDER, OR DIRECT-VISION FINDER (Fr., *Viseur direct;* Ger., *Direktsucher*)

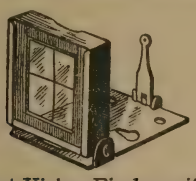
A finder in which the view or object to be photographed is inspected direct, the camera



A. Full-sized Direct-vision Finder with Wire Frame

being held up to the level of the eye. The full-sized direct-vision finder A consists of a rectangular wire frame C the size of the plate used, and

having a small opening or sight B fixed at a distance from it equal to the focal length of the lens with which the camera is fitted. If the sight is at the correct height, the eye placed against it will see through the frame the exact view included on the plate. The frame and sight are either detachable or made to fold down when not in use. When the camera is not of fixed focus, the frame should be attached



B. Direct Vision Finder with Lens

above the lens, so that it may move with it, to suit different extensions and to agree with any rise or fall given to the front. Another form of direct finder B consists of a concave lens, the sides of which are trimmed to a rectangular shape, with a small sight to indicate the distance at which it must be inspected. This gives a small but brilliant image. Cross lines are usually marked on the lens to assist in holding the camera level.

DIRECT POSITIVES (*See* "Positives, Direct.")

DIRECTOSCOPE

A stereoscope for the direct observation of colour (screen-plate) transparencies without reversal; invented and patented by M. G. Balmitgere in 1911.

DISGUISING THE CAMERA (Fr., *Déguisement de la chambre;* Ger., *Camera verstellen*)

In detective work it is frequently necessary to conceal the presence of the camera. This may sometimes be done by causing it to resemble some other article, such as a brown-paper parcel, a bundle of books, a brief bag, an opera glass, etc. A box-form magazine camera is easily made to look like a parcel by wrapping it somewhat carelessly in brown paper and tying with string, to which a luggage label may be attached. Holes should be torn for the lens and finder, leaving, however, a flap of paper hanging loosely over them to hide them until actually wanted. Many special forms of cameras have been made for purposes of disguise, such as one to work behind the waistcoat of the operator, the small lens protruding through a buttonhole; an apparatus for concealment in the hat; another resembling a lady's reticule, and so on.

Sometimes, in natural history photography, it is required to prevent animals, birds, etc., from knowing of the camera's proximity, and there are many ways in which this may be done. It may, for instance be hidden by an arrangement of boughs and twigs, or a moss-covered heap of stones, and possibly operated from a distance by a pneumatic or electric release. The precise method chosen depends on the nature of the surroundings. Considerable patience is called for, and it is not unusual for the operator as well as the camera to be completely concealed.

DISHES (Fr., *Cuvettes, Cuves;* Ger., *Schalen, Tassen*)

Dishes are described under the heading "Baths." (*See also* "Cleaning Dishes.")

DISINFECTANT

Any substance which kills bacteria and microbes, such as carbolic acid, formaline, corrosive sublimate, etc. Rapid oxidisers, such as potassium permanganate, also act as disinfectants.

DISPERSION (Fr., *Dispersion;* Ger., *Zerstreuung*)

The breaking up of white light into the various colours forming the spectrum, as seen when a prism is interposed in the path of a beam of light proceeding from a narrow opening or slit. Sir Isaac Newton was the first, in 1666, to show that rays of various colours have different refrangibility. The shorter the wave-length of the light the greater is found to be its refrangibility; thus red rays, which have the longest wave-length, are less refracted than the violet rays, which have the shortest wave-length. The same law applies to the non-visible infra-red and ultra-violet rays, at opposite ends of the visible spectrum. There are, however, a few cases in which the law is departed from. If, for instance, fuchsine is prepared in the form of very thin prisms, it produces a spectrum in which the red and yellow rays are more refracted than the blue and violet. This phenomenon is known as anomalous dispersion.

Newton predicted that dispersion could not be eliminated without at the same time losing the property of refraction. This is now known to be erroneous, since different kinds of glass may give practically the same amount of dispersion, yet have varying refractive properties. It is thus possible, by combining lenses made of dissimilar kinds of glass, practically to neutralise the effects of dispersion, a lens in which this is done being known as achromatic. (*See also* "Lens.")

DISSOLVING CHEMICALS

There is a right and a wrong way of dissolving and mixing most chemicals, and in some cases the method of dissolving affects the working powers of the solution. The slowest and possibly the worst way of dissolving a chemical is to place it in a bottle of liquid and let it stand. The quickest way is to have the salt, particularly soda, near the surface of the water and suspended therein in a canvas bag. However, for most solutions, the simple addition of chemicals, when not in large quantities, and frequent shakings will be sufficient. Chemicals usually dissolve more quickly in hot water than in cold, though there are some notable exceptions to this rule. (*See* "Solubilities.")

The order in which chemicals are dissolved or mixed has its influence on the working and keeping qualities of the solution. As a general rule, ingredients are added in the order given in the formulæ, otherwise special instructions are given. The following general hints should be noted:—Metol should be dissolved in the water before any other chemicals are added. Hydroquinone should always be dissolved after sodium sulphite. When pyrogallic acid is used, the

preservative—acid, metabisulphite, etc.—should be dissolved in the water before the pyro. When gold toning baths are made, the gold should always be added last, dissolved in water. Sulphuric acid should always be added gradually to the water and not water to the acid, otherwise combination takes place so energetically as almost to resemble an explosion, and some of the acid may be driven in the face or over the clothes. The list of solubilities presented in the table that is given under the heading "Solubilities" will assist in deciding whether much advantage will be gained by using hot or cold water. In some cases the temperature of the water is not of much importance. Developers such as pyro, metol, adurol, etc., are best dissolved in water that has been well boiled in order to get rid of the air, and then allowed to cool slowly.

DISSOLVING-VIEWS

These are obtained by the use of two lanterns, one above the other, or placed side by side. The discs of light projected by the two lanterns must coincide. Whilst a picture is being shown in the first lantern, the illuminant is quite low in the second one. A slide is placed in the second lantern, and then the light of the first one is gradually lowered whilst that of the second one is gradually turned up; the first picture dissolves away during the blending of the lights, and at the same time the second picture makes its appearance on the screen, taking the place of the first. To facilitate the operation (especially when lime-light is in use) the rubber tubing from the two jets is connected to a duplex gas-cock having four ways or channels, through which the gases may be made to pass. Thus, the oxygen and hydrogen of one illuminant is partially diverted or reduced, whilst the tap allows a full supply to pass to the other jet.

Dissolving effects are sometimes produced with bi-unial lanterns with their objectives furnished with iris-diaphragms opened and closed alternately. This method is very effective, and saves having to interfere with the adjustment of the illuminants.

Dissolving effects of a kind may be produced by means of a single lantern. The special carriers for obtaining such effects are divided into two classes. In one, a translucent screen gradually obscures the light, and just at the moment when the obscurity is complete, the slide is quickly changed by means of a carrier of the "to and fro" type. In another class, a second slide is pushed into a carrier which already holds a slide that is being shown; the second slide passes in front of the first, the latter is withdrawn, and then, by means of a spring, the out-of-focus slide is quickly pushed back into the place previously occupied by the first slide. This form of carrier was invented by R. R. Beard, and still enjoys popularity.

Dissolving effects in kinematograph pictures may be produced in two ways. If it is desired to make provision for such effects at the time of taking the original negative film, it is accomplished as follows: An iris-diaphragm, capable of completely closing at the centre, is fitted to the camera lens, and a short length of film is run through at the commencement whilst the iris is completely closed. Proceeding to wind through the film, the iris is gradually dilated and finally brought to its full aperture. The effect upon the sensitive emulsion is that the image of the object to be photographed fails to impress itself at first, and as the aperture enlarges in the iris, the film is more and more impressed, till at full aperture a full exposure is secured. The negative is then developed in the usual way. Such a negative will yield a positive in which the image gradually grows in strength, and as, at the commencement, no image will be seen, on projection the subject upon the screen will appear to develop out of thin air. If the image is intended to dissolve away and thus give place to a different subject, the iris on the camera is closed gradually whilst continuing to wind the film. Thus, a reverse effect will result when the negative is printed. Any subject may be treated in a similar way at the printing stage by regulating the illuminant used whilst printing. Thus, at the commencement, the light is kept very low, and as the films pass through the printer the illuminant is gradually turned full on till sufficient light is produced to secure normal exposure. Yet another method is to keep the illuminant at a uniform brilliancy and to regulate the exposure by modifying the speed at which the films are wound through the apparatus.

To make one kinematograph subject dissolve gradually into another, double printing is resorted to. At that point where the first print commences to weaken, through reduced exposure, a second negative (of the second subject) is placed in contact and gradually printed up, till it reaches full vigour. Hence, instead of one subject dissolving away entirely before a second begins to make its appearance, the image of the second subject will make its appearance, weak at first, but gradually growing in strength and finally becoming of full vigour, and this whilst the preceding image melts away.

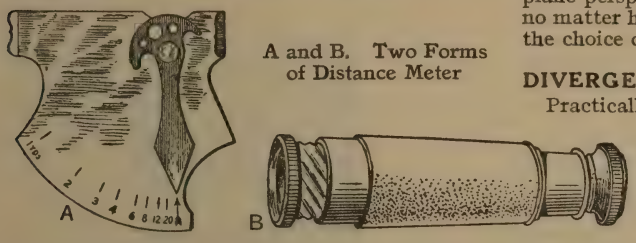
DISTANCE

That part of a picture farthest from the spectator, and generally quite subordinate to the rest of the view, to which, however, it must stand in proper relation. Occasionally it forms the *motif* of the subject. When a bluish distance is desired stronger than it would appear in the ordinary way, an orthochromatic plate with a deep yellow colour filter will be of great assistance. In telephotographic work it is often difficult, and sometimes impossible, to render distant objects clearly even by such means, on account of the interposition of large volumes of air of varying density.

DISTANCE METER, OR TELEMETER (Fr., *Télémètre*; Ger., *Entfernungsmesser, Distanzmesser*)

An instrument for estimating the distance of an object from the camera, so that it may be accurately focused by means of the focusing scale, without having to inspect the image on the screen. In one form A the distance is indicated on a scale by a small pendulum in the shape of a pointer. The appliance is held up to the eye, so that the latter looks along the sights towards the base of the object to be

photographed. The index then shows the angle made by the line of sight with a perpendicular drawn to the observer's feet, which angle varies with the distance of the object. By pressing slightly with the forefinger on the top of the pendulum it is prevented from moving when the telemeter is lowered for examination. Another type of distance meter consists of a small telescope which indicates the distances on which it is focused. In the pattern illustrated at B,



A and B. Two Forms of Distance Meter

the instrument has first to be fully extended and the eyepiece focused correctly on the grain of the ground glass inside the telescope. The eyepiece tube is then scratched with a knife, so that the observer may always in the future be able to secure the focus suited to his particular vision. This having been adjusted, the object glass is revolved until the object to be photographed is seen sharply on the ground glass. The arrow will then point to the correct distance of the object on the engraved scale.

DISTANCE SCALE (*See* "Focusing Scale.")

DISTILLED WATER (Fr., *Eau distillée;* Ger., *Destilliertes Wasser*)

Pure water, obtained by vaporisation in a still and subsequent condensation of the vapour.

Distilled water is advised for many chemicals, and as it may be obtained so very cheaply from a chemist, it should be used when recommended, and most certainly for such chemicals as gold chloride, silver nitrate, and uranium nitrate, which are both expensive and prone to decompose in water containing impurities. Whether distilled water should be used for all developers, toners, etc., depends upon the character of the ordinary water available. With many of the common chemicals used in photography—all sodiums, potassiums, etc.—tap or other water good enough to drink will serve quite well.

In process work, distilled water is used in large quantities for making up the silver bath. The use of tap water is possible, but it occasions some amount of trouble.

DISTORTION (Fr., *Distorsion;* Ger., *Verdrehung*)

It is a common error to attribute every unpleasing effect in the "drawing" of a photograph to distortion, but, as a matter of fact, true distortion is very limited in photography. The most common and the most serious form is known as curvilinear distortion, and is confined to single lenses and to certain forms of compound ones. In the case of the single lens this distortion is shown by a bending of the lines, which becomes more pronounced towards the edges of the field, the bending being outwards from the corners when the diaphragm is used in front of the lens, and inwards when the diaphragm is placed behind the lens. (*See* "Curvilinear Distortion.") Distortion by convergence of straight lines is treated under the heading "Swing Back." Violent perspective, which is sometimes wrongly called distortion, is quite distinct from it. If a photograph taken with a rectilinear lens, however wide its angle may be, is tested by the inflexible rules of plane perspective, it will be found to be correct, no matter how ridiculous it may appear owing to the choice of too near a standpoint.

DIVERGENT RAYS

Practically all the light which the eye sees or which enters a lens is composed of divergent rays. Every point in an object emits rays which diverge in all directions from which it is visible, and the lens of the eye or of the camera causes them to converge and form an image. When an object is extremely remote the degree of divergence is very small, and such rays are termed parallel.

DIVERGING LENS

A concave lens, or one which is not capable of producing an actual image. It is often called a "negative" lens. The magnifying element of a telephoto lens belongs to this class.

DIVERSITY

In pictorial composition, the introduction of many varied objects each claiming more or less attention. Unless kept strictly within bounds it results in confusion.

DIVIDING BACK (*See* "Repeating Back.")

DODGING NEGATIVES AND PRINTS (*See* "Control in Printing.")

DOLLAND'S PROCESS

A method of toning and intensifying platinotype prints, worked out by A. W. Dolland. Its advantages are that it strengthens a weak platinum print, and at the same time changes it to a pure black or blue-black colour. The weak black picture to be strengthened and toned—the more recently made the better, as prints more than about ten weeks old are difficult to treat—is soaked in warm water and then laid face upwards on a sheet of warm glass. All superfluous water is blotted off, and a thin covering of glycerine is gently spread over the surface by means of the finger-tip or a broad camel-hair brush. A strong solution of gold chloride (15 grs. to 7½ drms. of water) is then made up, and a few drops of it brushed over the glycerine-covered print as evenly as possible. The print soon begins to gain strength, and at the same time the colour of the print gradually changes to a warm black, then cold black, and finally blue-black. As soon as the desired effect is attained the print is well washed in water in order to remove the gold and glycerine, care being taken during the treatment with gold that the high lights remain unaffected. After washing, and in order to ensure the reduction and elimination of any gold compounds which

are liable to be formed with the sizing of the paper, the toned print should be sponged back and front with any clean-working alkaline developer, the formula specially recommended by Dolland being:

A.	Metol. . .	100 grs.	10 g.
	Sodium sulphite .	2 ,,	100 ,,
	Water to . .	20 oz.	1,000 ccs.
B.	Potass. carbonate	240 grs.	24 g.
	Water to . .	20 oz.	1,000 ccs.

Use equal parts of A and B, and finally wash for about a quarter of an hour. All the above operations are best carried out in the strongest daylight possible.

DONISTHORPE PROCESS

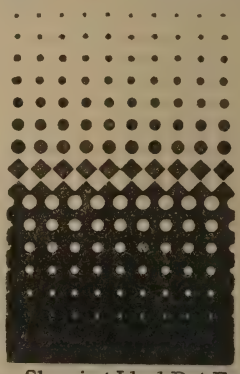
A printing method, invented by Donisthorpe, in 1908, a modification of the old hydrotype process. A negative is taken in the ordinary way and after developing, fixing, and washing is immersed in a mixture of vanadium chloride, potassium ferricyanide, ferric chloride, and oxalate. The silver image is probably converted into chloride and ferricyanide and dissolves, whilst vanadous salts are precipitated *in situ* which harden the gelatine. After washing, the negative is immersed in aniline dye solutions which are absorbed by the hardened gelatine, and not by any unchanged gelatine; the dye is finally removed by absorption by a film of damp gelatine, thus obtaining a print. After one print has been made, the negative is again dyed for a few minutes, rinsed, and another impression is taken.

DOPPLER'S PRINCIPLE

A principle discovered by Doppler, by means of which it is possible to tell with considerable accuracy the rate of travel of a star to or from the earth. It being assumed that a star at a fixed distance emits light waves of a given length at a uniform rate, it is obvious that the number of ether waves striking the observer's eye will be constant in a given time. If, on the other hand, the star be travelling away, fewer waves will meet the observer's eye in a given time, as the waves have further to travel. The converse naturally holds good with a light source travelling towards the observer. Now, if fewer waves strike the eye in a given time, the wave-length must be increased, whereas if more waves strike the eye the wave-length is decreased. In the first case the monochromatic light would incline towards the red, and in the latter case more towards the violet end of the spectrum. The displacement is naturally dependent on the velocity of movement of the light source, and this is usually measured for the F or H β line, and taking the velocity of light as 299,860 kilometres per second, it is obvious that about 61 kilometres per second would result in an increase or decrease of 1 Angstrom unit in the wave-length of this line.

DOT FORMATION

An expression used in relation to the half-tone process when describing the dot effect produced by photographing through the ruled screen. The ideal dot formation is such that in the deepest shadows of the negative (the most transparent parts) the dots are reduced to mere pin points, and as the tones deepen towards the highest lights (the darkest parts of the negative), the dots grow in size until they join together and leave small transparent open-



Gradation Showing Ideal Dot Formation

ings between. Above is shown a diagrammatic representation of the ideal dot formation.

DOUBLE CONCAVE

(*See* "Biconcave.")

DOUBLE CONVEX

(*See* "Biconvex.")

DOUBLE DARK-SLIDE

(*See* "Dark-slide.")

DOUBLE EXPOSURES

Two exposures may be made on one plate—each one filling half the plate—by having a shield of metal or thin wood fitted to the camera back close to the dark slide. The shield covers half of the plate while the other half is exposed; then the position of the shield is changed so that for the next exposure it covers the exposed half while the second half is exposed. The shutter of the slide may be drawn right out for each exposure; the shield forms a perfect protection for the part covered. By means of such a fitting a half-plate may be used for two quarter-plate exposures.

A few years ago this method of making two exposures on one plate was very frequently used by amateur photographers for producing a type of portrait that could not be attained by any other method excepting combination printing. (*See* "Doubles.") Another form of double exposure is that which is frequently utilised for obtaining "spirit" or "ghost" photographs. A plate is exposed in the usual manner on the subject in which it is intended that the "ghost" should appear. The lens is capped while the figure that is to form the ghost is introduced. Then a short supplementary exposure is made, care being taken to avoid moving any part of the subject between the two exposures. A transparent shadowy image of the added figure will appear, solid objects in the picture being visible through it.

An annoying form of double exposure is that obtained by exposing the same plate twice, by accident. The best method of avoiding this is to make it a rule to change the plate immediately after exposure when using a magazine hand

YELLOW

RED

YELLOW + RED

A FOUR-COLOUR PRINT
AND THE
CONSECUTIVE STEPS
IN ITS PRODUCTION

YELLOW + RED + BLUE + GREY

The original, of which this is a small portion, is an Autochrome Photograph by H. ESSENHIGH CORKE, F.R.P.S.

Especially taken for "Wild Flowers as They Grow"

BLUE

YELLOW + RED + BLUE

GREY

camera, and to expose all plates in rotation according to the number on the dark-slides when these are employed.

DOUBLE EXTENSION (Fr., *Double tirage;* Ger., *Doppel Ausdehnung*)

A camera is said to be of double extension when its construction allows the racking-out of the bellows to about twice the focal length of the lens that is fitted. The usual arrangement consists of an "extension frame" sliding in grooved rails on the baseboard, and worked by a rack and pinion. When two extension frames are provided, allowing the bellows to be racked out to about three times the focal length of the lens, the camera is said to be of triple extension. The advantages of a long extension are that near objects may be successfully photographed, copying done full size or even larger, and telephotographic work undertaken.

DOUBLE IMAGES

A double image on a negative is the result of one of two causes. Either the camera has moved during the exposure, or else the subject has moved. If the latter, any moving part of the subject will show a double outline, while the remainder of the subject will be sharp. If the whole of the image is doubled, it indicates movement of the camera, laterally or vertically, according to which outlines show the movement.

A double image in a print, if the negative is sharp, indicates that the paper has moved during printing, due to want of care in examining.

DOUBLE PRINTING (*See* "Combination Printing.")

DOUBLE REFRACTION

When a ray of light passes through certain materials it is not only refracted but divided into two parts, one of which, called the ordinary ray, obeys the ordinary laws of refraction, while the other, or extraordinary ray, does not. The most usual method of exhibiting this phenomenon is to place a cross or other figure behind a slab of Iceland spar, when it is seen to be duplicated. The polarisation of light depends upon double refraction. (*See* "Polarised Light.")

DOUBLE TONES

In silver printing these are frequently a source of trouble. Owing to the lighter portions of the subject toning more rapidly than the darker ones, the light parts will be quite cold in tone, a blue-grey, while the shadows may still remain a brick red; for, as a general rule, when the light parts begin toning at a more rapid rate than the shadows, they continue in the same way throughout the operation, the shadows taking comparatively little gold. This defect most frequently arises from one of two causes. Either the toning bath is too weak, or there is too small a quantity of gold for the prints in hand. The combined toning and fixing bath does not give double tones.

DOUBLE TONING

This is a method frequently adopted in silver printing for obtaining tones that cannot be secured by a single bath. Almost any chloride emulsion printing-out paper will give fine black or brown-black tones by first toning with gold and then with platinum. A simple and satisfactory method of working is to use a self-toning paper. The prints should be washed, toned with platinum, and then fixed, preferably in a fixing solution that has been rendered slightly alkaline with ammonia. A good toning formula is:—

Potassium chloroplatinite	3 grs.	.	·3 g.
Sodium chloride .	30 ,,	.	3 ,,
Citric acid . .	30 ,,	.	3 ,,
Water to . .	20 oz.		1,000 ccs.

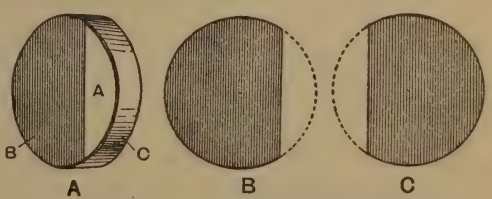
An entirely different double toning is that of toning bromides and lantern slides to two distinct colours. (*See* "Lantern Slides, Two-colour Toning of.")

DOUBLE TRANSFER

A term used in the carbon process to describe the method of working when the reversed print given by the ordinary single transfer method is inadmissible. The print is transferred first to a temporary support on which it is held during development. (*See* "Temporary Support.") After drying it is transferred to a paper which is to be its final support, and it is the necessity for this second transfer that gives it the title of double transfer. (*See also* "Carbon Process.")

DOUBLES

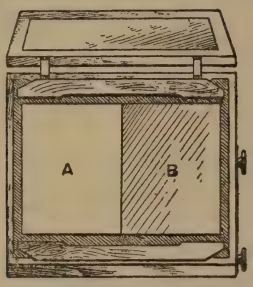
A popular form of freak photograph, showing two pictures of the same person on one plate, as, for example, a man playing cards with himself, etc. This kind of picture was at one time (1880) somewhat popular among professional photographers, but the work is now almost exclusively confined to amateurs. Each half of the plate is exposed separately, thus allowing the figure to be taken twice on the one plate. Many methods of making such exposures have been advocated and a few accessories placed on the market, but excellent doubles may be made with the simplest of fittings.



Cardboard Cap to Lens, Used in Producing Doubles

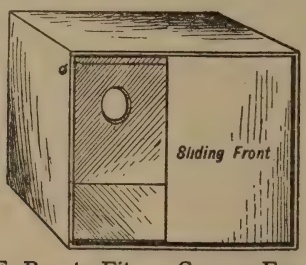
For the partial lens cap method a lens cap is made of blackened cardboard, as A, the ring C being made to fit easily the front of the lens, and then covered on one side with blackened cardboard B from which a segment is cut off as shown at A; exactly how much to be cut away should be found by trial. Having cut away a very small portion, the partial cap is placed on the lens and the picture examined on the ground glass. The cutting away must be continued until one half of the picture is dark and the other half lighted. The dividing line as seen on the screen will not be cleanly cut, but will have a diffused or vignetted effect. About

the proportion shown on the right-hand side will have to be cut away, certainly not one half of the card, as might be supposed. During the cutting, the cap is revolved on the lens mount so that both halves of the view can be seen, and



D. Card in Reversing Back

when one half vignettes or merges into the other a trial plate may be exposed. It requires accurate cutting to allow of one exposure merging into the other, and to prevent the join between the two separate exposures being distinguished. If, for example, a thin under-exposed band shows down the centre of the plate the covering part B is too large, and not enough has been cut away; if, on the other hand, there is a dense over-exposed strip, the aperture A is too large, thus causing the centre to receive a double exposure. To use the cap, it is placed on the front of the lens with the opening on the right-hand side, as in B, and the sitter is then posed and focused on the half (left hand) of the screen on which the picture is seen, exposure shutter set, dark-slide put in, and the exposure made in the usual way, the shutter of the dark-slide being drawn out all the way. For the second half, the camera must not be moved, the slide is closed, taken out, and the partial cap revolved to the opposite side—that is, to the position shown at C. The sitter then assumes a position that will be visible upon the second half of the focusing screen, the partly exposed plate is again inserted in the camera, and the second exposure made on the unexposed half of the plate. Obviously the two exposures



E. Box to Fit on Camera Front

must be of exactly the same duration. For this method the camera must be provided with a shutter working behind the lens.

If the camera has no shutter, and exposures are made by removing the cap, a cut cap cannot be used. The circular card from which the segment has been cut off, and without a ring, can be fitted into the lens hood itself, and of course covered over with the ordinary cap with which the exposures are made.

Another favourite plan of making doubles is to fix a card in the reversing back of the camera (*see* D), the card being blackened and of a size to cover one half of the plate. The first exposure is made with the card at B, so as to photograph the half marked A; the card is then removed to A in order that the remaining half of the plate B may be exposed. The card used at the back needs to be cut even more accurately than that used in the lens, because being so near the plate the dividing line between the two exposures is more clearly cut. It is desirable to select a background with vertical lines which will not clearly show the division—a bookcase or a door, for example—and the inevitable line between the two parts of the image is so arranged that it coincides with a strongly-marked natural line in the view.

Another accessory (somewhat analogous to the first method described) is shown at E. This is a box of very thin wood, blackened inside, about 6 in. long, 3 in. deep, and 4 in. high; it has a round hole cut in the centre of the back part so that it may be fitted on the front of a lens and used as a kind of partial lens cap. The front of the box is fitted with a sliding panel or half lid, which slides across the front in grooves, allowing each half of the plate to be exposed in succession. Over all there is a proper lid which serves as a cap. This box front is used after the manner of the partial cap, and the exact width of the sliding panel can only be found by experiment as before, one side of the sliding panel being cut accordingly. The latter may be worked by a knob on the centre of the panel itself, or by means of a wire.

In all cases it is advisable to arrange the whole scene first, and to allow the sitter to try both positions, examining the ground glass carefully to see that all is included, and that no part of the sitter—feet and legs, for example—gets beyond the centre, or the whole effect may be spoilt.

A style of "double" portrait (two or more positions at one sitting and with one exposure) is that known as a "polypose portrait."

DOUBLET

An old term used to denote a double combination lens, and usually composed of two cemented meniscus lenses. The ordinary portrait lens is classed as a doublet. The rapid rectilinear may be considered the typical doublet.

DRAGON'S-BLOOD (*See* "Gums and Resins.")

DRAINING RACK (*See* "Drying Rack.")

DRAM, OR DRACHM

In apothecaries' weight 60 grs., or one-eighth of an ounce; in avoirdupois weight $27\frac{11}{32}$ grs., or one-sixteenth of an ounce. In fluid measure one dram is 60 minims, or one-eighth of an ounce. The French equivalent to one dram (fluid measure) is $3\frac{1}{2}$ cubic centimètres. (*See* "Weights and Measures.")

DRAPER, JOHN WILLIAM

Born at St. Helens, Lancs, 1811; died on the Hudson River, 1882. Anglo-American author and scientist. Went to America in 1833 and became professor of physical sciences in Hampden Sidney College, Virginia (1837), and professor of chemistry in the University of New York (1839). He made researches into the chemical action of light, radiant energy, spectrum analysis, and photography. In 1839 (details published March 31, 1840) he was the first to make a portrait of a living person, the subject being his sister Dorothy Catherine Draper, whose face was made white by powdering and given an exposure of about half an hour in bright sunlight. Draper was also the first to photograph the moon (March 23, 1840); it was necessary to give an exposure of twenty minutes, a daguerreotype plate being used.

DRAPERY FOR FIGURE SUBJECTS

Portraits of draped subjects are popular with photographers chiefly because drapery offers so many opportunities for artistic treatment, being often more pleasing than everyday dress, which, more particularly in the case of feminine garments, goes so quickly out of fashion. As regards the material and colour of drapery, opinions largely differ; some photographers use ordinary muslin, others a cheaper fabric called tarlatan, while a few favour bunting and silk shawls. Cheese-cloth is probably the best drapery for the figure, and muslin for the head. The material used should not be quite new, and should have been washed, wrung out and rough dried; new materials contain too much stiffening to allow of their following the lines of the figure properly, and this is particularly the case with tarlatan, which needs a thorough washing in hot water to adapt it to the purpose. White flimsy material photographs too white in ordinary lighting, and it is therefore better to make it slightly dingy or less actinic by dyeing a pale yellow colour, by steeping it in coffee, or by allowing it to become somewhat soiled with usage.

Blue, yellow, and even black muslins are also advocated by many workers, but strong blues and yellows should be weakened by rinsing in water and hanging in the sunshine to rough dry. The lines of the figure show very well indeed through thin dark muslins, and good effects are obtainable by draping a thin white material over a dark one; but in all cases of head and shoulder drapery more depends upon the softness and the character of the lighting than upon the actual composition of the material. Upon the lighting, exposure, and development depends whether the material will photograph the same tone as the flesh.

Drapery for the full length figure need not be so thin as that used for head and shoulder studies. Muslin and tarlatan are available, but cheese-cloth is much more amenable to the production of artistic folds, the choice largely depending upon whether the more or less dim outlines of the figure are required to show or not. No attempt should be made to reproduce the lines of orthodox clothes with cheese-cloth, the best effects being obtained by, as it were, hanging the material upon the figure or by imitating the ancient Greek style. One of the many ways in which the Greeks differed from all other ancient peoples was in their method of covering their bodies. They did not make what may be rightly called clothes; apparently they cut the cloth to the proper sizes, hemmed the ends, decorated the pieces with lines of coloured embroidery, and sewed on buttons. To make a serviceable cheese-cloth garment in the Greek style, and suitable for full-length female figures, the width of the piece must be, for the long and flowing principal garment, equal to the height of the model. If seams are unavoidable, let them run vertically, they can then be more or less hidden in the folds. The width of the principal garment must be equal to double the distance between the extended finger-tips; the width will thus be found to be ordinarily a little more than twice the person's height. Fold the piece vertically. Next, on each side of the centre, and at such a distance apart as to leave an opening for the head, place a button and button-hole; this opening should be the width of the model across the shoulders. Along the upper edge other buttons or hooks and eyes may be placed at about 2 in. intervals extending to the ends. This garment, put on over the head, has a closed side at the left, leaving the right open. The draping of this garment will alone give all the vertical effects desired and can be made to expose either of the arms, either of the shoulders, or the whole of one side of the figure. Undoing one or more of the buttons or hooks allows it to slip from either of the shoulders, and with only two buttons there is a sleeveless garment. If all the fastenings are done up and the others are put close to the neck, the whole figure can be covered, and yet one side may be exposed at will. By putting a girdle or sash around the figure an entirely new set of folds is obtained; and pulling the garment up through the girdle and allowing it to fall gives a characteristic and Diana-like effect. With a crossed girdle or cincture over the shoulders still another series of folds is obtained which confines the garment to the figure and shows its outlines, and one has at the same time the alternative of bare or covered arms, and one side open. Over this, to add to the beauty and variety of the folds, is sometimes put a kind of mantle, consisting of a piece as long as the main garment, horizontally, but only half its vertical depth. This the ancient Greeks buttoned on the shoulders and made into the same artistic folds as the under-garment. When the ends are cut off diagonally they look very well, and may be made to form a series of folds like pleats. Add to this a very long strip or scarf, about 24 in. wide and of indefinite length, to throw over the shoulders, to twist about the arms, or to festoon about the figure, and the photographer has all the necessary materials for the ordinary drapery of the full-length figure.

DRAWINGS, COPYING

For methods of copying drawings, see under the headings, "Engravings, Copying," "Copying," "Copying Illustrations for Translation into Line Drawings," and "Copying Stand."

In process work, the copying of drawings is

brought to a high degree of perfection. Cameras, lenses, prisms, copying stands, arc lamps, and all other apparatus are specially designed for obtaining the most perfect negatives. Parallelism between the various parts of the camera and the copyboard is carefully studied. All possible means for overcoming vibration are adopted. Lenses are chosen to give extreme definition to the margins of the plate, as well as uniform illumination; and the prism or mirror employed for reversing must not in any way impair the definition of the lens. The arc lamps, which are generally preferred to daylight for commercial work, are very powerful, and reflectors are employed to concentrate the light on the copy. Care is taken to avoid reflections from the surface. Where the copy is a wash drawing or painting in colours, isochromatic plates and screens are employed. For copying bluish wash drawings, or drawings in which Chinese white has been used (tending to reproduce darker than the original), æsculin or quinine filters are used to correct the effect of ultra-violet light.

DRAWINGS MADE FROM PHOTOGRAPHS

There are many methods of making line drawings from photographs, and most of them involve the destruction of the originals. In essence, the lines of the photograph are gone over with waterproof ink and the photograph then bleached. Matt prints on bromide, gaslight, or P.O.P. paper may be used, the last-mentioned being fixed and washed, but, if it can be avoided, not toned. The ink used must be waterproof, Indian or Chinese, applied in any convenient manner, as, for instance, with an ordinary pen, a mapping pen, a camel-hair pencil, etc. When sufficient work has been put on the print, the photographic basis is entirely destroyed with a powerful solvent of the silver image. Any reducer or bleacher may be used, but in practice one that acts quickly and without stain has its advantages, and therefore a mixture of iodine and potassium cyanide, both of which are poisonous, is the best. The formula is :—

10% solution of iodine in methylated spirit	60 drops	125 ccs.
10% solution of potassium cyanide in water	10 „	21 „
Water	1 oz.	1,000 „

This may be used stronger if the action is not quick enough. The solution should not be allowed to touch the fingers any more than is unavoidable. The mixture ought to destroy the photograph in half a minute; the picture is then washed for five minutes and afterwards dried.

The following process is used by many trade workers: Make ordinary prints on a smooth surface bromide paper, exposing and developing in the usual way; after developing, harden in an alum bath, wash and dry, but do not fix. Then draw over the picture with good waterproof Indian ink, and when the latter is quite dry bleach in a copper-bromide bath made by dissolving 50 grs. of potassium bromide in 1 oz. of water, 50 grs. of copper sulphate in another ounce of water, and mixing the two solutions together. If after bleaching the drawing requires further working up, it may be well washed and redeveloped with any weak dry-plate developer, dried, worked on, and again bleached. After a good rinse the bleached image may be totally destroyed, and the lines left permanently black upon a white ground by passing the bleached print through a potassium cyanide or "hypo" bath. A saturated solution of mercuric bichloride may also be used for bleaching out the silver image. When the results are required for use as originals in line photo-engraving, the bleached prints should be kept from the light as much as possible, or they may turn yellow.

A simpler process of drawing on a photographic base is that of using a blue (ferro-prussiate) print, preferably one that has not been made too dark by over-printing. As the light blue colour will not photograph, the drawing may be reproduced by line photo-engraving processes without any bleaching, although the blue image can be removed, if desired, by immersing in dilute liquor ammoniæ, by a prolonged washing in hard water, or better and quicker still, by immersing in a solution made by dissolving 1 part of potassium oxalate in 6 parts of water. Solutions of sodium carbonate and caustic potash will also bleach blue prints.

In process work, various methods are adopted for making drawings from photographs. If the photograph is mounted, and must not be removed from the mount, it is best to lay over it a piece of tracing gelatine, scratch the outline with a sharp point, and then to rub blacklead or red chalk into the lines. This drawing is turned face down on to a sheet of Bristol board, or other surface to be drawn upon, and rubbed down with the handle of a tooth-brush, or by other convenient means. The drawing is in this case reversed. It may be obtained the right way by re-scratching on the back of the gelatine and filling in this side instead of that originally traced, or it may be reversed by means of prisms when making the block.

A better way is by the use of the "Norwich Film," a gelatine with a matt surface which can be drawn on with pencil, crayon, or ink. The resulting drawing may be used as a photographic positive, or may be converted into a negative by flowing with a non-actinic varnish. When dry, the greasy ink or crayon is removed with benzole or other suitable solvent.

The bleaching-out process, already described, is perhaps the best way of converting a photograph into a drawing.

Unmounted prints may be traced down on to Bristol board or drawing paper by rubbing the back with blacklead or red chalk, or by putting common transfer paper between the print and the drawing surface. The outlines of the photograph are then gone over with a hard pencil or stylus.

DRESS FOR SITTERS

The part played by dress in photography is an important one; and a question put frequently to the photographer is: "What dress shall I wear?" As a general rule the more simple the

dress the better if the portrait is to be what may be termed a lasting one. Feminine fashions change rapidly, and a photograph taken of a sitter dressed in the prevailing fashion soon becomes "dated," as it were. Colour is not of the importance it used to be, as, with the modern isochromatic plates and screens, fairly correct interpretation of tone has become possible, and the rendering of a yellow dress as black, or a blue one as white, ought now to be a thing of the past. W. Ingles Rogers carried out, many years ago, some important experiments, and the salient facts in his report may be summarised as follow: A gentleman's ordinary dress is not sufficiently artistic to warrant a full-length presentment; its colour is preferably black. In the case of uniform and special dress, the full-length is preferable. Ladies require more careful treatment from the standpoint of dress. As a rule, long dresses make the best pictures, both because the length of drapery gives height and dignity, and because graceful and flowing lines are then more easily obtained. As a matter of fact, the female figure has no waist. It is a pure invention, and a conventionality of form. If, however, such a thing has to be considered and sustained, the best place for confining the dress is just below the armpits. This disguises any lack of length in the lower limbs, and grace and dignity are gained without the usual inartistic curving of the hips.

Next to form comes colour, and in this connection no rule can be laid down that will produce perfect results with unvarying fidelity. Much depends on style and complexion; but, all other things being equal, monochrome (black, white, or grey) gives the most favoured results. Gaudy tints are opposed to the principle on which the "science" of photography is based, and are only tolerated by the camera when neutralising an otherwise monotonous effect.

In cases of necessity—for example, where the sitter's wardrobe does not contain what the perfection of photographic art requires—the table of tints, with their relative photographic qualities, given in the preceding column, will repay a careful study.

Colour of Dress	*Tint in Photograph*	*Combines best with*
White ..	White ..	Black, dark blue, red, or brown
Yellow ..	Grey ..	Black or dark green
Salmon ..	„ ..	„ „ „
Pink ..	„ ..	„ „ „
Fawn ..	„ ..	„ „ „
Scarlet ..	Dark grey	White or dark blue
Dark red ..	Black ..	White, light green, light blue or grey
Brown ..	Black ..	White, light green, light blue or grey
Light green	Light ..	Dark green, dark red, brown or black
Light blue or violet	„ ..	Dark blue, dark red, brown or black
Dark green	Black ..	Light green, yellow, or grey
Dark blue or mauve	Medium	Light blue, white, or grey
Grey ..	Grey ..	White or black
Black ..	Black ..	White, light blue, green, or grey

As for materials, the following are the most suited to photography, arranged in the order of preference:—

Name of Material	*Combines best with*
Velvet	Linen, lace, crape, and fur
Silk	Crape, velvet, and fur
Cloth	Linen, lace, crape, and fur
Serge	Linen and silk
Calico goods ..	Linen and cloth
Woollen goods ..	Linen and silk
Fur	Silk, lace, and fringes

Silver ornaments are preferable to gold, and if diamonds are worn they should be slightly smeared with soap to deaden their reflection during the brief period of exposure. Long, drooping curls or waves are effective in semi-profile, but give to the full-face sitter an effect of solidity. The arrangement of the hair gives a man his individuality in appearance, and therefore should not be interfered with.

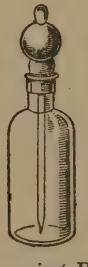
DRIFFIELD (*See* "Hurter and Driffield.")

DROP SHUTTER (Fr., *Obturateur à guillotine*; Ger., *Guillotine Verschluss, Fallverschluss*)

A shutter in which a panel, having a central opening and working in a pair of grooved upright rails, is caused to fall by gravity in front of the lens, uncovering and re-covering the latter as the opening passes it. This kind of shutter is simple and easily made, but is somewhat cumbrous, and will not give very rapid exposures. It has been quite superseded by the roller-blind shutter.

DROPPING BOTTLE (Fr., *Flacon compte-gouttes*; Ger., *Tropfglas*)

A bottle for the delivery of a liquid or solution in small quantities, or in separate drops. There



A. Dropping Bottle with Pipette

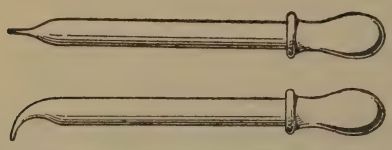
B. Dropping Bottle with Slotted Stopper

are various patterns. In one, A, a pipette or dropping tube is let into the stopper. Another, B, allows the drops to pass to a suitable lip in the neck by turning the stopper, in which a slot is cut. When not in use, a second turn of the stopper shuts off communication with the lip. Schuster's dropping bottle resembles a flask

drawn out at the top to a fine curved point, and having a stopper at one side for the introduction of the solution.

DROPPING TUBE (Fr., *Pipette compte-gouttes ;* Ger., *Tropfrohr*)

A tube having one end drawn out to a fine point, and provided at the opposite end with a rubber bulb, as illustrated. The bulb is compressed, and the tube dipped into the liquid or solution to be used ; on removing the pressure from the bulb the liquid rushes up the tube.



Two Patterns of Dropping Tube

Having withdrawn the tube, the liquid may be delivered in drops as required by a gentle pressure on the bulb. Another form is without a bulb. With this, the tube is dipped into the solution, its upper end closed with the finger, and the tube withdrawn. If the depth of solution does not allow of this, the liquid must be drawn up by suction with the mouth, and the upper end of the tube closed with the finger before withdrawing it from the solution, but this is very inefficient. On removing the finger the liquid is delivered in drops. It is risky to use this kind with poisons, lest the solution should reach the mouth. A fountain-pen filler is an excellent dropping-tube for quite small quantities.

DROPS (Fr., *Gouttes ;* Ger., *Tropfen*)

Drops and minims are supposed to be synonymous, but such is not the case. A minim is one-sixtieth part of a dram, but a drop may measure more than a minim, or less, as shown by the following list, which gives the average number of drops which go to make up one dram : Water, 71 ; nitric acid, 96 ; hydrochloric acid, 70 ; sulphuric acid, 100 ; ether, 290 ; alcohol, 130 ; turpentine, 220 ; castor oil, 157 ; olive oil, 168. Drops also vary according to the way they are dropped and the receptacle they are dropped from, but happily in most photographic operations extreme accuracy as to the size of a drop does not matter. A useful arrangement in the form of a squirt, and called a minim-meter, is sold by most chemists for the purpose of measuring drops, or, more correctly speaking, minims.

DRUMMOND LIGHT

An early name for the limelight, which is described under its own heading.

DRY COLLODION

This term is sometimes applied to collodion emulsion which has been precipitated and washed with water, and occurs in the form of fine flocks or granular masses, which only require solution in alcohol and ether to form a normal collodion emulsion. (*See also* " Collodion.")

DRY COLLODION PROCESS

An old process, not now used, in which plates were coated with an iodised collodion, sensitised in a silver bath, washed, and bathed in certain so-called preservative solutions, such as albumen, honey, beer, tannin, coffee, laudanum, etc., most of which were hygroscopic to some small extent, and thus kept the film slightly damp. The first of the dry collodion plate processes of any real service was that published by Dr. J. M. Taupenot, on September 8, 1855. The original method was to pour over the collodionised and sensitised plate a solution of iodised albumen, dry, and dip for a second time into a silver nitrate bath, wash, and dry. Plates prepared in this way kept good for six or eight weeks. Mayall suggested a similar process in May of the same year. The great drawback of the process was its slowness, the plates needing about five times the exposure of wet plates. On May 21, 1855, Dr. Hill Norris, of Birmingham, published his famous process, Fothergill following with his process in 1856. Dry collodion plates then became articles of commerce, the Hill Norris collodio-gelatine plate (patented September 1, 1856) becoming the most popular.

DRY ENAMEL PROCESS

A method used in printing the half-tone image on to zinc or copper for etching. The sensitive solution consists of—

Ammonium bichromate	125 grs.	25 g.
Powdered white sugar	270 ,,	54 ,,
Chromic acid . .	80 ,,	16 ,,
Albumen, from	2 eggs	7 eggs
Liquor ammoniæ .	120 mins.	24 ccs.
Water . . .	10 oz.	1,000 ,,

An alternative formula is—

Grape sugar . .	232 grs.	113·6 g.
Albumen . . .	338 mins.	165·7 ,,
Ammonium bichromate	46 grs.	22·5 ,,
Chromic acid . .	36 ,,	17·6 ,,
Liquor ammoniæ .	120 mins.	24 ccs.
Distilled water . .	4½ oz.	1,000 ,,

After coating the plate with this solution and printing, it is dusted with finely powdered anhydrous sodium carbonate, or magnesium carbonate, brushing with a soft flat brush until the image is clearly visible. A small room, in which the atmosphere can be kept moist by standing a bowl of water on the floor, is necessary, so that the plate can absorb the requisite amount of moisture to attract the powder. The plate is burnt in, as usual in the enamel process, and then placed in water, when all the parts which have absorbed the powder develop away quite clean. If any scum remains, a little moist salt or dilute caustic potash will remove it.

DRY MOUNTING

The Derepas is perhaps the most perfect method known of mounting prints and of building up multiple mounts. The surface of the print is not affected ; there is nothing that will harm the most delicate print by any process ; there is no cockling, even when a stout print is mounted on a thin paper ; and it is durable when properly carried out. A sheet of thin tissue is prepared with shellac, the prepared tissue being commercially obtainable. A piece of the tissue is

touched with a hot iron, which will make it adhere to the back of the print, and both print and tissue are then trimmed together. They are next placed in position on the mount, covered with a sheet of paper, and subjected to heat. This is accomplished either by going over it with a hot flat-iron, or subjecting it to pressure in a heated press made for the purpose. The heat causes the shellac to melt and so secure perfect adhesion between print and mount. Everything being dry there is no expansion with its subsequent contraction, and print and mount remain smooth and flat. There are no special difficulties attached to this method, and the results are excellent.

DRY PLATES (Fr., *Plaques sèches;* Ger., *Trockenplatten*)

Sheets of glass of given sizes coated with gelatine emulsions. The term arose in the early days to differentiate them from wet collodion plates. The introduction of the gelatine dry plate marked a new epoch in photography. There is some difference of opinion as to who was the actual inventor, Burgess, Maddox, Kennett, Wratten, and others all working at the same time in practically the same direction. It was, however, on September 8, 1871, when Dr. Maddox published an account of his experiments, that the first hint was given. On July 18, 1873, J. Burgess, of Peckham, advertised and sold ready-made emulsion with which photographers could coat glass and so make their own dry plates; Kennett followed, and on November 20 of the same year took out a patent for his "pellicle," with which photographers could make their own plates. Improvements followed rapidly, Bolton, Sayce, Wratten, Mawdsley, Berkeley, Abney, Bennett, and others doing much to bring the dry plate to perfection and to make it an article of commerce. As far as can be ascertained, the first ready-made dry plates were advertised in April, 1878, by Wratten and Wainwright and the Liverpool Dry-plate Company (Peter Mawdsley), the plates by the latter firm being called the "Bennett Plates," and the price for quarter-plates being 3s. per dozen. It was not until 1880 that gelatine dry plates became really popular.

In process work, considerable progress has been made of late years in the use of dry plates. Excellent commercial dry plates, specially made for line, half-tone, or colour work, are now obtainable. The methods of handling are not very different from those in ordinary photographic work, except that greater care has to be taken to avoid over- or under-exposure and fog; the lines must be kept perfectly clear and sharp, and in half-tone work great care and skill have to be exercised to obtain sharp dense dots of the right size and quality. In this respect dry plates are more difficult to handle than wet collodion. Backing is found to be an advantage; the negatives usually have to be cleared with ferricyanide and "hypo" (Howard Farmer's reducer); and intensification, preferably with silver cyanide, is generally necessary. For the making of dry plates, *see* "Coating," "Emulsion," etc. For the various manipulations, *see* "Exposure," "Developing," "Fixing," "Toning," "Washing," etc.

DRYING BOX OR CUPBOARD (Fr., *Étuve, Armoire;* Ger., *Trockenofen*)

A light-tight box or cupboard used in drying gelatine plates after coating, and for other photographic purposes. The chief requirement is the circulation of a current of dry air, in order that the internal air may be continuously drawn away, carrying with it by degrees the moisture from the plates. The temperature of the drying cupboard requires to be raised, but perfect ventilation is of greater importance. A pattern recommended by W. K. Burton consists of a box with a closely-fitting light-tight door, and having light-trapped air openings at top and bottom. Beginning near the bottom, a bent channel or flue runs up against one side of the box, a gas burner being inserted in it near the top. When the burner is lit it draws a current of air through the flue from below, and consequently ensures a constant circulation of air in the box. Another kind of drying cupboard is warmed from beneath by a gas-ring or oil stove, a sheet-iron bottom being fitted. Light-trapped openings at the lower portion of the sides and a cowled ventilator at top furnish the necessary air current.

In process work, the arrangement for drying collotype plates is usually in the form of a box or trunk supported about 12 in. from the floor on four legs. The bottom consists of an inverted sheet-iron box, under which is placed a gas-ring or pipes. Holes are punched in the side of the box to prevent the gas becoming choked. The wooden part of the box is about 18 in. deep. About 6 in. from the top are two iron bars, resting on ledges at the sides of the box. These bars are provided with screws placed at suitable distances with their points upwards. The plates rest on these screws, and by adjustment of the latter can be levelled up, so that the gelatine solution on the plates will not run off. The bottom of the box is usually covered with sand to equalise the heat. The lid of the box is covered with gauze or an open-textured cloth, so that the moist air can pass through. A thermometer is inserted into the box through a hole in the lid.

Process workers find a drying cupboard necessary for quite a number of purposes; in one convenient form the bottom takes the form of an inverted sheet-iron box, and there are holes in the sides to allow the gas fumes to escape, or a flue pipe can be led out from the back. In the sides of the wooden part, just above the sheet-iron bottom, are holes for drawing in a current of air; these holes are covered with a baffle-board sloping towards the bottom. Shelves or racks can be placed in the cupboard. On the top a metal cowl ventilator is placed. For heating, an ordinary gas-ring burner is placed underneath the bottom. The cupboard can be elaborated by placing an electric radiator inside and an electric fan on top to draw out the air. The incoming-air can also be made to pass through an opening packed with damp cotton-wool, so as to stop any dust entering. For colour-sensitising dry plates the cupboard must, of course, be made perfectly light-tight. Such a cupboard is very convenient for drying photo-lithographic paper and carbon tissue, and will be found generally useful.

DRYING MARKS

These in negatives are most frequently patches or portions which are stronger or weaker than the remainder of the image, such portions producing corresponding defects in the print. These markings may be due to defective working, or to causes beyond the worker's control. With regard to the first, a plate may be drying very slowly, and when partly dry the conditions of drying may be changed to accelerate the drying of those parts that still remain wet. The part accelerated will almost always show greater density than the remainder, and at times a well-defined mark may separate the two parts.

The second cause is uneven drying of the plate in the course of manufacture. When plates are racked for drying, no matter how perfect the ventilation of the drying-room may be, the edges, where the emulsion always tends to thinness of coating, will always dry more quickly than the centre, the result being that a line appears round the edges. The exact cause of this is a little obscure, but the most satisfactory explanation is that given by Homolka, who ascribes the foggy line—for this is what edge drying marks actually are—to a diffusion of the faint traces of soluble haloid left in the emulsion from the thin dry edge to the thicker and moister centre. Actual drying marks from uneven drying of plates during the manufacture are now rarely met with, though in the early days of dry-plate photography they were of frequent occurrence, and manifested themselves in precisely the same manner as in the unequal drying of negatives—that is, by central patches of greater or less density due to this portion being more or less sensitive than the margins.

DRYING NEGATIVES

Negatives should be dried as quickly as possible consistent with drying evenly—that is, with uniformity in the rate of drying. A current of dry air is best, but a drying cupboard is good. In any case, the air should have free and uniform access to their surfaces; they should not be dried close together, as in a draining rack, neither should they lean against a wall face downwards. The place chosen should be as free from dust as possible, and not too warm, or the gelatine may melt. In summer and autumn particularly, it is necessary that the plates should be dried in a place protected against flies and other insects. Cockroaches are said to be fond of eating wet gelatine.

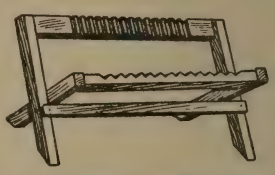
DRYING PRINTS

Prints in all processes should be freely exposed to the air in drying, so that the operation may be rapid. The most satisfactory method in most cases is to hang the prints from a line or a lath, either by means of clips or by pins through one or two corners. An alternative method is to blot off as much moisture as possible, either with a soft towel or blotting-paper, and then lay the prints face upwards on a clean white cloth until dry. A drying cupboard is the best place for the latter method.— In any case, they should be dried in a place as free from dust as possible. (For imparting a high gloss to prints in drying, *see* " Glossy Surfaces.")

DRYING RACK, OR DRAINING RACK

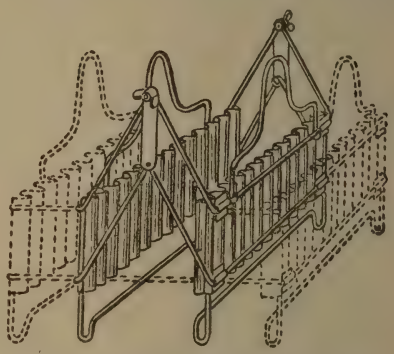
(Fr., *Séchoir, Égouttoir;* Ger., *Trockengestell*)

A wooden, metal, or porcelain stand with grooves, in which negatives, etc., are stood up to drain and dry after washing. The ordinary wooden folding pattern is shown at A, while B



A. Wooden Drying Rack

illustrates an ingenious expanding metal rack, which may be adjusted to hold various sizes of plates. Many washing tanks are fitted with a removable metal rack which may be used for drying. Negatives should not be placed closely together in the racks when drying, or the process



B. Expanding Metal Drying Rack

will be very slow, and uneven patches sometimes occur. The closeness of the usual grooves is in this respect somewhat misleading. It is better to spread out the negatives.

DUFAY DIOPTICHROME PROCESS

This employs a screen plate of French manufacture. A gelatinised glass is coated as to two-thirds of its surface with a greasy material, which acts as a temporary resist, in the form of lines, points, or grains of geometric or irregular shape. The present plate consists of lines with rectangles in between. The bare parts are dyed and the whole surface varnished and treated with a solvent of the greasy material so as to lay bare the unstained gelatine. Half this surface is then again covered with a greasy substance, and the bare gelatine again dyed, again varnished, the greasy material again dissolved, and the last portion of the unstained gelatine dyed. A compensating filter is used, and the plate is issued with a special panchromatic plate fitting into a frame with nickel pins which allow of complete registration of the positive and colour screen. Coloured plates to this work show the formation of the Dufay plate, and a typical result obtained with this plate.

The plates must be manipulated in absolute darkness or with the maker's special dark-room filter. The developer recommended is:—

Metol	53 grs.	6 g.
Sodium sulphite	1½ oz.	72 ,,
Hydroquinone	17 grs.	2 ,,
Potassium bromide	17 ,,	2 ,,
Liquor ammoniæ (·880)	130 mins.	15 ccs.
Distilled water to	20 oz.	1,000 ,,

For use, mix with an equal quantity of water and continue development for four minutes.

Rinse the plate for some minutes, and immerse in—

Potassium or ammonium bichromate	44 grs.	5 g.
Sulphuric acid	95 mins.	10 ccs.
Water to	20 oz.	1,000 ,,

When the image has dissolved, wash for several minutes till all the yellow tint has disappeared, and immerse in the first developer or preferably in—

Metol	22 grs.	2·5 g.
Sodium sulphite	1 oz.	50 ,,
Hydroquinone	44 grs.	5 ,,
Potassium carbonate	220 ,,	25 ,,
Potassium bromide	18 ,,	2 ,,
Distilled water to	20 oz.	1,000 ccs.

Re-development takes about three minutes, and should be done in a bright light. The plate may be reduced with "hypo" and ferricyanide, and intensified with mercuric chloride followed by ammonia.

DU HAURON, DUCOS

A Frenchman, born in 1839, in Langon, Gironde, and one of the first to describe in detail the three-colour process (1867). In 1864 he patented a species of kinematograph. He was also the inventor of the anaglyph, and the first to describe a screen-plate process of colour photography.

DUOTYPE (Ger., *Duplex-Autotypie*)

A half-tone in two printings, one being with a light tint ink, and the other in a black or photo-brown, the idea being to imitate the tones of a photograph. Sometimes both printings are from the same block, but the best results are obtained from two blacks etched differently.

DUROLENE

A kind of unbreakable glass in which wire is embedded. It has been recommended for studio roofs, but its tint stops a large amount of actinic light.

DUST PREVENTION

Dust is often a great trouble in photographic work, both in the field and in the work-room. Dust in the camera and on the lens is the most frequent cause of trouble, hand cameras being more prone to the defect than others because of the usual practice of carrying them unprotected. Dusty lenses cause flat and misty pictures. Dust will find its way into the lens through the slits used for Waterhouse and rotating diaphragms, and the only preventive is to fit, when possible, a band of velvet ribbon round the lens tube to cover up the slots as much as possible; in the case of Waterhouse diaphragms the band may be kept completely over the slot when the diaphragm is not in use. Rubber bands have been recommended, but these contain substances that tend to mark and discolour the lens mounts. The plate-changing arrangements in hand cameras, and shutters working inside, are often the means of stirring up dust which settles upon the lens and plate. Frequent dusting of the interior of the camera and plate sheaths is advisable, but unless done carefully more dust will be deposited than removed. Coating the innermost parts of the camera with glycerine or vaseline has been suggested; such a coating will naturally hold down the dust and prevent its flying about, but inasmuch as it is liable to become messy and to need frequent changing, the method is not recommended. The focusing screens of stand cameras are occasionally thinly coated with vaseline in order to make them more transparent, and the coat serves as a kind of trap for the dust; in this case the cleaning is quite easy, but the cleaning of the interior of the bellows is quite another matter. Dark-slides invariably attract dust, but they can easily be dusted, and any coating of grease might interfere with the sliding shutter or find its way to the plate. Dark-slides having draw-out shutters are the greatest offenders; the light-trap at the top of the slide, which closes the aperture when the shutter is completely withdrawn, is made usually of either velvet or rubber, and this scrapes or wipes the dust from the sides of the shutter as it is drawn out and returned, thus in time forming an accumulation. Thorough dusting of the light trap and the interior of the slides is an obvious remedy. Dust settling upon the plate causes many spots, and it is of but little use dusting a plate before putting it into the dark-slide if it is to be exposed to a miniature dust storm in the camera.

Plate dusters are articles of commerce, but if they are not kept scrupulously clean they put more dust upon the plates than they take off and do more harm than good. Plates rarely need dusting with a brush; when taking them from the box or dark-slide, a gentle knock with the edge upon a table will do all that is necessary. Of dusters, an old well-washed silk handkerchief is one of the best.

Frequently unsuspected resting-places for dust are the top rims of bottles and the crevice between the cork and the bottle neck; before pouring a developer from a bottle, the rim and mouth should be wiped, otherwise any accumulated dust may find its way to the plate and cause spots. The corks of bottles should be kept covered with a paper or cardboard cap.

Many professional dark-rooms and all plate-making rooms have their floors kept damp in order to prevent dust.

The utmost care is necessary when mixing chemicals, more particularly pyro and other developers, to prevent small particles of the developer in the form of dust flying about the room and settling upon sensitive surfaces.

DUST SPOTS

Miniature transparent spots on negatives due chiefly to the causes given in the preceding article. If the spots are actual holes in the gelatine, showing the bare glass beneath, they

are due to dust in the process of manufacture and are real pinholes; but these are very rarely met with nowadays. Dust spots are more or less numerous and of various shapes and sizes, and they occur where dust specks have rested on the plate during either exposure or development. In the former case they prevent the light from reaching the emulsion, and in the latter the developer is prevented from reaching it. The remedy for spots caused in this way (it is a mistake to call them "pinholes") is careful spotting, but obviously prevention is better than cure. Particles of developer dust which may float about the dark-room and settle upon undeveloped plates and bromide papers invariably cause black spots, but such spots will also appear when the developer has not been properly dissolved, and it is very difficult at times to discover the real cause of the trouble. Black spots on a negative are best left alone, and the resultant white spots on the print touched out. Etching or pricking away with a needle on the negative has been recommended, but it needs particular care, as otherwise the film will be ruined.

DUSTER, PLATE (Fr., *Torchon aux plaques;* Ger., *Plattenabstaüber*)

A strip of wood having a piece of plush attached, and used for dusting dry plates before insertion in the dark-slide. Sometimes a wide camel-hair brush is employed, but this is still less satisfactory, being more liable to put dust on the plate than to remove it. Neither device is recommended. (*See also* "Dust Prevention.")

DUSTING OR GRAINING IN PROCESS WORK (Fr., *Grainage;* Ger., *Staubkornung*)

There are several processes of photo-engraving dependent on the laying of a ground consisting of fine resin, bitumen, or other similar material. Such a method is used for aquatint etching instead of the old way of flowing on the resin emulsified in alcohol.

For a process of colour work much practised in France, called chromo-typogravure, a resin grain is laid on zinc plates, and a set-off is laid down on the plates from a key plate to guide the etcher in stopping out the various colours. This is done by means of an acid-resisting varnish, so that the resin ground forms the lighter tints.

In the photogravure process the laying of the ground is an important operation. Finely powdered bitumen is generally used, and after being deposited on the copper plate and fixed by heat, a carbon print is developed upon it to form the resist for etching.

The dusting for the foregoing processes is done by means of a dusting box. This may be of either the turnover pattern or the fan pattern, the former being suitable for small plates and mostly used by amateurs. The box is turned over and over to shake up the bitumen, then the plate is put in and the box allowed to stand for a shorter or longer time, as may be demanded by the character of the grain required. In the fan dusting box the powder is stirred up in the semicircular zinc bottom by means of a revolving brush, and, after allowing to stand for a few moments for the heavier particles to settle, the plate is put in. The longer it remains in the box the finer will be the grain. Powdered lac is also sometimes used for dusting.

DUSTING-ON (POWDER) PROCESS (Fr., *Procédé aux poudres;* Ger., *Einstaubverfahrung*)

Known also as the "Powder Process," based, as are the other carbon processes, upon the oxidising action of chromic salts upon organic matters. In the present instance, the organic matter loses its tackiness or stickiness under the action of light and refuses to retain dust. The process is largely used in the production of photo-ceramics and for the intensification and doctoring of faulty negatives when these are of great value. Various substances are available for the support of the powder picture, but none is better than ground opal or pot opal glass. As the effect of the light in the process is to cause the film to refuse to take powder, the parts acted upon remain light; this being the case, a transparency (positive) must be used for printing from and not a negative, as a print from the latter in this process would be a negative. The requisites are sensitising mixture, opals, powder, and a transparency of excellent quality. Although opal has been named and is recommended, glass, ferrotype, and other supports can be used. In any case, it must provide a proper contrast to the powder. Thus, if the dust or powder used is silver or gold bronze, the image may be produced on a dark background, for which a ferrotype tinplate will serve.

The support must be cleaned and sensitised in a solution consisting of a gum, a hygroscopic substance, and a light-sensitive medium. The following formula is one of a great number between which there is but little to choose :—

White sugar . .	200 grs.	20 g.
Gum arabic . .	250 ,,	25 ,,
Ammonium bichromate	200 ,,	20 ,,
Methylated spirit .	1 oz.	50 ccs.
Water . . .	20 ,,	1,000 ,,

An old, and possibly the original, formula, still in use, is as follows :—

Water . . .	10 oz.	1,000 ccs.
Dextrine . .	240 grs.	48 g.
Grape sugar . .	240 ,,	48 ,,
Potassium bichromate	240 ,,	48 ,,

The first of these formulæ is said to possess many advantages. The gum and sugar should be covered by the water and dissolved by heat; when cool, the other ingredients are added. The spirit is used simply to make the solution flow over the plate more evenly, and more or less may be used as desired. After washing, the wet plate is flowed over with the sensitive mixture, drained for a few minutes, and then baked in an oven until bone dry. The operations up to baking may be carried on in daylight, but as the plate dries it becomes sensitive and should therefore be removed and examined in a dull light. The plate is then ready for exposure under a positive, and, as in many other cases, this is the most difficult part of the process, for so much depends upon atmospheric conditions.

The duration of exposure can be found only by experiment, but as a rough guide it may be

said to be one minute in bright sunlight on a summer's day, when a transparency of average density is used. When exposure is complete, the plate is "developed" by dusting on a powder. The choice of a powder is almost unlimited, but it must be exceptionally fine, to ensure which it should be sifted through a muslin bag. Ordinary powder colours from an oil-shop may be used. Ivory black and Indian red are good colours, used alone or mixed in varying proportions, while some use levigated graphite.

For printing, the sensitive plate should be warmed, or it may be warmed by being printed in strong sunlight. An image will be seen faintly upon the sensitive plate when removed from the frame. The plate is held in the fingers or on a pneumatic holder, and some powder sprinkled over the surface, immediately spread with a soft camel-hair brush, and kept on the move until sufficient detail and density have been secured.

Development proceeds rapidly as the plate cools, and it should be assisted by a gentle stream of air blown from the mouth across the plate, the current not being strong enough to disturb the powder or cause excessive moisture; the air must not be absolutely dry, and the powder must be kept on the move with the soft camel-hair brush. Almost any depth can be obtained in any part of the picture by patient re-application of the powder rather than by attempting to make too much powder adhere at one time. As the progress of development is visible and under perfect control, it is not difficult to bring out or keep back certain parts, and in this way very artistic results may often be easily obtained.

When development is complete, the powder picture may be coated with plain collodion and washed free from greasiness; the plate is now transferred to a 5 per cent. solution of potash alum until the yellow bichromate salt has been removed. Fixing with collodion as just described may be dispensed with when a duplicate negative is being made upon glass, all that is necessary being to expose it again to the light to get rid of all further tackiness. When, however, it is desired to fix the picture—as, for example, when it is upon an opal base—and it is not convenient to use the collodion "fixer," the picture may be washed over with the following solution:—

Water . .	1 oz.	100 ccs.
Sulphuric acid .	2 drms.	25 ,,
Methylated spirit	2 oz.	200 ,,

Mix in the order given. The plate is treated with this until all the yellowness has gone, is then washed gently in water, and dried by gentle heat. The collodion fixer is preferable, as with the acid solution there is a risk of entirely losing the image. Flatness in a picture is caused by over-heating or over-exposing the plate or by developing in too dry an atmosphere; in this connection care must be taken to keep white light from the image before fixing.

This process has been used for the production of pictures in colour. In 1888 a process was introduced by Germeuil-Bonnaud which consisted in exposing a plate coated with treacle, sodium borate and potassium bichromate, under an ordinary positive transparency. It was then dusted with various coloured pigments which, it was claimed, adhered selectively to the different parts of the picture, a claim that has not been substantiated. Dr. Miethe has worked out a variation of the idea. Glass plates are coated with the following mixture:—

Gelatine . .	9 grs.	5·8 g.
Sugar candy .	300 ,,	194 ,,
Potassium bichromate	90 ,,	58 ,,
Water . .	3½ oz.	1,000 ccs.

The plates are dried in an oven and exposed under a positive while warm. Three prints will be required from three negatives representing the three different colour sensations. Development is performed by brushing on the plates suitable transparent powder colours. The yellow print is made first, stripped with collodion, and affixed to a card with gelatine solution. When dry, this is coated with a thin film of shellac, and the red and the blue prints superimposed upon it in the same manner.

A formula specially compounded for ceramic work, but which will also serve for all papers and articles, is:—

Gumming Mixture

A.	Fish-glue . .	1 oz.	100 ccs.
	Glucose . .	4 ,,	250 g.
	Glycerine . .	10 drops	·5 ccs.
	Water . .	10 oz.	1,000 ,,

Sensitising Mixture

B.	Am. bichromate .	1 oz.	100 g.
	Water . .	10 ,,	1,000 ccs.

Mix together equal parts, and use as already described.

DYES AS COLOUR SENSITISERS

The peculiar property possessed by certain dyes of conferring upon the silver halides increased colour sensitiveness was discovered by Vogel in 1873, has had a most important influence on the advancement of photography in almost every branch, and since his time the number of dyes which act as sensitisers has been and is being continually increased, though the practically valuable ones are but few. It was but natural to expect that an examination of the chemical constitution of the various sensitisers would show some common property or grouping of elements to which might be ascribed the sensitising power, but up to the present no definite conclusion can be come to. It has been further suggested that the sensitiveness of the sensitisers themselves to light was the cause of their action, but some of the most fugitive dyes are not sensitisers, whilst others which are very stable are. Then, again, it has been pointed out that many of the dyes are photo-electric, and that here electrons may be set free which act on the silver halide, causing increased ionisation of that part of the silver halide which forms the latent image. The subject is so complicated, and the mass of material available for examination is so meagre, that the resulting definite conclusions are disappointingly small.

There are certain generally accepted facts as to sensitisers, and these have been most concisely summarised by Eder as follows:—(1) The absorption spectrum of neither the alcoholic nor of the aqueous solution of the dye nor of

the dyed gelatine agrees with the position of maximum action on the sensitive emulsion. (2) The position of maximum action of the dyed silver bromide always lies slightly nearer the red than the absorption maximum of any solution of the dye. (3) The position of maximum of absorption of the dye in gelatine and the maximum sensitising action generally differ by about 30 $\mu\ \mu$ or wave-lengths. (4) The absorption spectrum of a dyed silver halide coincides with the maximum sensitising action. (5) The dye must stain the silver halide itself to be a sensitiser, but all dyes that thus stain are not sensitisers. (6) Fluorescence, or fugitiveness to light, of the dye appears to play no part.

As most of the important sensitisers are briefly described under their respective names, reference should be made to these. The principal azo sensitisers are glycine red, benzonitrol brown, Pluto black, dianil black R, and wool black 4 B. To the rosaniline family belong ethyl violet and formyl violet. The phthaleine group is one of the most important, as it comprises the eosines and erythrosine. The acridine dyes are chrysaniline, acridine yellow, and acridine orange. The best sensitisers, particularly for red, belong to the chinoline or quinoline group, and are isochinoline red, dicyanine, and the isocyanines orthochrom T, pinaverdol, pinachrome, homocol, isocol, etc.

DYES FOR COLOURING PHOTOGRAPHS

In choosing dyes for colouring photographs on a gelatine basis it is important to take into consideration first their stability when exposed to light, and secondly their affinity to gelatine. The following are the most suitable: acid violet 7 BN, wool blue N extra, patent blue, fast acid violet, acid green, alizarine cyanine (blue violet), tartrazine (yellow), chinoline yellow, brilliant orange, Ponceau 5 R (red with violet tinge), new coccine (bright red), erythrosine (bluish red), fast brown, water soluble fast blue and water soluble nigrosine (blue black). All these colours will take well on gelatine if it has not been hardened. For collodion prints it is advisable to use albumen as a vehicle for the dyes.

DYES, IMPROVING NEGATIVES WITH

(*See* " Retouching, Chemical.")

DYNACTINOMETER

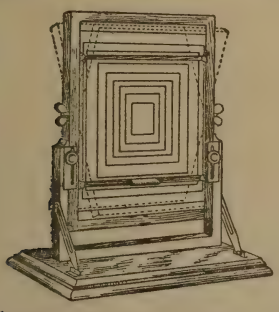
(Fr., *Dynactinomètre;* Ger., *Dynaktinometer*)

An instrument by which the actinic power of light may be measured, or the rapidity of different lenses compared.

E

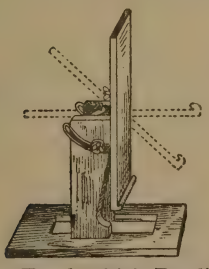
EASEL, ENLARGING (Fr., *Chevalet d'agrandissement, Chevalet à reproduction;* Ger., *Vergrösserungs-Stativ*)

A support to hold the bromide paper during the operation of enlarging. In order to ensure parallelism with the negative in the enlarging camera or lantern, the easel is made to run on rails; or it is fixed, the lantern or camera being moved instead. The easel may consist simply



A. Typical Modern Enlarging Easel

of an upright board supported by a firm base or crosspieces, but it is a great convenience if it possesses a swing movement, which will permit the correction of vertical lines that are shown as slanting in the negative, through the tilting of the camera when taken. Formerly the worker was content to fasten up the bromide paper with pins; now many easels are provided with spring clamping bars, which save time and also hold the paper flatter. Another arrangement is to attach



B. Enlarging Easel which Readily Assumes Horizontal Position

to the easel a hinged frame carrying a sheet of glass, this being fastened down over the paper. A illustrates a typical modern enlarging easel, with rising, falling, and swing movements; while B shows an easel of very solid construction, which, besides allowing for rise and fall and for any degree of swing, may instantly be changed to a horizontal position for pinning the paper, and as easily returned to its former upright position, in which it automatically catches. Some easels are made with a ground-glass focusing screen, so that the projected image may be focused from the back; these may, or may not, be provided also with a dark-slide to carry the paper. The easel is preferably painted black; otherwise, when only a part of the negative is to be enlarged, a good deal of stray light will be reflected from the easel. The white paper used to focus on should preferably be removed, or covered with something black, before fastening up the bromide paper. In the majority of cases, however, this may be omitted without any ill result; but it is imperative if plates are used, as when making enlarged negatives, etc.

It is sometimes necessary in enlarging to correct the distortion in the original negative by swinging the easel out of parallelism. In a typical easel for process work, both a vertical and horizontal swing can be obtained, and the negative can also be turned in its own plane to any axis. Max Jaffé, of Vienna, has done some remarkable panoramic copying with an easel of this kind, securing pictures with an enormously wide angle by ignoring the original distortion in the negative and correcting it when copying, at the same time joining up the image on one negative to another to secure a large combination negative.

EAU BROME

Bromine water; used at one time in the daguerreotype process, for stopping the action of light.

EAU DE JAVELLE (Fr., *Eau de Javelle;* Ger., *Bleichwasser, Javellische Lang*)

A clear, colourless fluid smelling of chlorine, used as a reducer, "hypo" eliminator, and stain remover; known also as sodium hypochlorite, ozone bleach, and Labarraque's solution. It was one of the earliest of the bleaching solutions, and was first made at Javelle, Paris; hence its name. There are several methods of making it, the best for photographic purposes being: Add 1 oz. of sodium carbonate to 4 oz. of water, shake well, and add 320 grs. of bleaching powder (chloride of lime), and shake well again. Filter, shake up the residue with water, and again filter. The filtrate is a solution of hypochlorite (*eau de Javelle*). Acidified with oxalic acid, it forms an active stain remover, but it is safer to use it without the acid. Its use is not now recommended, safer methods having superseded it.

EBONITE

A black compound of indiarubber or caoutchouc, sulphur, and pigment, with occasionally certain filling substances, used for the shutters

of dark slides, developing dishes, etc. It is the same as vulcanite except that the latter is made in many different colours.

Ebonite has many uses in photography owing to its waterproof and acid-proof character. Its drawback, however, is its brittleness, though this can be overcome, and a flexible ebonite obtained, which is useful for some purposes. Ebonite has been used for dipping baths for wet collodion work, but has not proved popular because of a supposed tendency for the bath to be injuriously affected. More probably this is due to the difficulty experienced in cleaning such baths.

Ebonite dippers for the silver bath, however, survive, and have the advantage of not being so fragile as glass. Ebonite plate lifters for flat dishes and trays are also largely used. Draw-out shutters for dark-slides, iris diaphragms and Waterhouse stops, developing dishes up to about 15 in. by 12 in., and much larger flat trays (with an outer wooden casing) for silver baths, are made of this material.

In process work, ebonite is useful for parts of etching machines which have to be exposed to the acid.

EBONY STAIN

Ebony stain (Stephens's) is preferred to Indian ink by some pen-and-ink artists. It makes a good line, and dries with a glossy surface which photographs well. It has the drawback of not being waterproof, and of more quickly clogging drawing pens than does Indian ink. It is cheap, and if otherwise suitable it is worth while trying to waterproof it by adding a solution made by boiling together 2 oz. of shellac and ½ oz. of borax in 10 oz. of water, and straining.

EBULLIOSCOPE (Fr., *Ébullioscope;* Ger., *Ebullioskop*)

An apparatus for testing the purity of a liquid or solution by ascertaining the temperature at which it boils. When a liquid contains dissolved substances its boiling point is usually higher, and a concentrated solution has a higher boiling point than a weaker one.

EBURNEUM PROCESS

An obsolete process invented in 1865 by J. M. Burgess, of Norwich, in which a carbon or collodion transparency, transferred from a sheet of waxed glass, was backed up with an ivory-like mixture, which gave it the appearance of being on ivory. Burgess's original instructions were, briefly, as follows:—A good collodion transparency is necessary, and the glass upon which it is taken should be waxed to facilitate stripping. Either an iron or pyro developer is used, preferably the following:—

Pyrogallic acid .	3 to 6 grs.	7 to 14 g.
Citric acid . .	3 ,,	7 ,,
Glacial acetic acid	20 drops	42 ccs.
Water . . .	1 oz.	1,000 ,,

Fix with cyanide, well wash, and tone with gold. When dry, strips of paper are pasted round the plate on the back and then turned up so as to form a dish. The plate is placed level and coated with the following mixture at a temperature of 100° F. (38° C.):—

Gelatine . .	5 ,,	500 g.
Glycerine . .	½ ,,	50 ,,
Zinc oxide . .	1 ,,	100 ,,
Water . . .	10 oz.	1,000 ccs.

When set, the plate may be allowed to dry spontaneously and the film detached. The process was slow and difficult, for which reason it was little used. Imitation eburneum prints widely known as "Ivorytypes" (*which see*) were more popular.

ECLIPSES, PHOTOGRAPHING

The portrayal of the varying phases of an eclipse, whether of the sun or moon, is always of interest to the photographer. The exact times at which these phenomena will occur can always be ascertained a considerable time in advance from the almanacs, thus enabling the photographer to prepare any special apparatus he may desire to fit up for the occasion.

Dealing first with eclipses of the moon, the chief interest in these lies in the gradual change in shape as the moon traverses the earth's shadow. When fully eclipsed the moon may be either quite invisible, or showing of a more or less bright coppery colour. The most satisfactory manner of obtaining a picture of the eclipse with an ordinary camera is to set up the camera on its tripod and focus sharply; then swing until the moon is near one end of the ground glass. The end chosen should be that *from* which the moon's image will travel in its motion across the sky owing to the earth's rotation. This is always from east to west, so that, remembering that everything is inverted in the camera, the first exposure should be arranged near the right-hand side of the plate if the observer is in the northern hemisphere. Load the dark-slide with isochromatic plates of medium rapidity; draw the slide, and expose with the cap. Give about a quarter of a second exposure. After making one exposure, leave the apparatus as it stands, with slide still drawn, for say five minutes. During this interval the moon's image will have travelled towards the left on the plate, and another similar exposure may then be given. Repeat this procedure at intervals of about five minutes until the eclipse is over. On developing, which will be exactly like the development of an ordinary subject and needs no special description, a series of pictures of the moon will be found extending across the plate, and of varying shapes, from full circle, through crescents to the dusky total eclipse. A pleasing variation to the above procedure may be made if the observer has a telephoto equipment, as he can with it obtain larger pictures of the moon's phases, showing more details of the surface structure. It will not be possible, however, to obtain the whole series of pictures illustrating the progress of the eclipse on a single plate owing to the increased magnification. If the series is required, then several loaded plate-holders must be got ready to hand and the plates changed as found most convenient.

With eclipses of the sun, the problem is somewhat different, chiefly on account of the very great actinic power of even a small section of the uneclipsed solar disc. If the eclipse is only partial, the arrangement described above for the lunar eclipse may be repeated except in regard

to the exposure. This must be rendered as short as possible. If a focal plane shutter is to be employed, the slit in the blind must be made as narrow as possible, and the tension run up to the maximum. Should a diaphragm or cap shutter only be available, then it will be advisable to stop down the lens to the smallest aperture possible and also use the shutter at its greatest speed.

The greatest interest, however, becomes centred in the solar eclipse which becomes total, the dark moon blocking out all the usual brilliant white disc. Then it is that one is able to see that wonderful appendage to the sun, the corona, and the ring of ruddy atmosphere, the chromosphere. On a small scale these features may be photographically recorded by means of cap exposures, but they will have to be fairly rapid, say a quarter of a second, owing to the rapid motion of the moon. With a small mechanical stand having provision for driving the camera at the same rate as the drift of the moon much longer exposures may be given, and the coronal extensions portrayed to a greater distance from the moon's limb. Owing to the special nature of the coronal light isochromatic plates should be employed for this class of work, and, preferably, the most rapid variety available. For recording solar eclipses on a very large scale, special cameras with lenses of great focal length have been at various times employed. For example, cameras with lenses of 40 feet focal length were used by an American party under Professor Campbell in India. The lens was situated at the narrow end of a tube, propped up on the top of a wooden skeleton tower. The plate holder was in a canvas-covered portion near the ground, and in one case the moon's motion was counter-balanced by moving the plate-holder by a simple form of clepsydra.

One of the most interesting and instructive applications of photography to a total solar eclipse consists in the use of the prismatic camera. In its simplest form this is the ordinary camera with a simple prism adjusted outside the lens in such a position that the light from the eclipsed sun must pass through both prism and lens before it reaches the photographic plate in the camera. By this means is obtained a series of pictures of the sun's surroundings, instead of a single one as before. Every different substance present in the sun's atmosphere will show as a different ring or series of rings, and it is by a study of such photographs—or spectrograms, as they are technically called—that astronomers have been able to learn what substances are present in the solar atmosphere. In a particular example of the prismatic camera, the lens aperture is 6 inches, and the focal length of the lens is 7½ feet. There is a single large prism of 45° refracting angle rigidly attached outside the objective, and the whole instrument is fixed to a strong equatorial mounting driven by a delicately adjusted clockwork movement, so that exposures of any desired duration can be given.

ECZEMA PROCURATA

A name given to the skin disease caused by the metol developer. For further particulars, see under the heading "Metol."

EDGING (Fr., *Bordure ;* Ger., *Einfassung*)

In wet collodion negative making, especially for process work, the glass plates are generally edged with indiarubber solution to prevent the film from being washed off during the operations of developing, intensifying, etc. Albumen and gelatine are also used for the same purpose, but with these materials it is generally the practice

Edging Brush

to coat the plate all over as a substratum. A useful device for edging is shown above. A small camel-hair brush has a strip of wood bound to the side of it, and the two are pushed through a cork, which stoppers a bottle or test tube containing the rubber solution.

EDGING NEGATIVES FOR CARBON PRINTING

Negatives intended for carbon printing require an opaque margin, called a safe-edge. A narrow margin of the print must remain white, as otherwise it will be difficult to transfer the film. This opaque margin may be produced by painting the edges of the film with water colour, or opaque varnish may be applied to the glass side of the negative. Another method frequently adopted is to attach narrow strips of thin, opaque paper to the negative, or to a piece of plain glass. In the latter case this glass is placed in the printing frame outside the negative, and one glass may be used for many negatives.

EDINOL (Fr. and Ger., *Edinol*)

A developer, known also as "Paramol," under which name it was originally introduced in 1901, but the two agents are stated by some not to be exactly the same. It occurs in a faint yellowish crystalline powder, having the formula C_6H_3 OH CH_2OH NH_2, and it is soluble in twelve times its weight of water. Its factor number is 20, and it therefore stands midway between the slow-working developers, such as pyro, hydroquinone, and adurol, and the quick-working developers, metol, amidol, etc. It can be used as a single-solution or a two-solution developer, and works well when combined with hydroquinone. Edinol is extremely sensitive to the action of bromide as a restrainer, so much so that from 10 to 30 per cent. of a saturated solution of sodium bicarbonate instead of bromide has been recommended in cases of over-exposure. It is clean-working and is particularly suitable for bromide and gaslight papers and transparencies. The formulæ for one-solution and two-solution developers are as follow :—

One-solution

Sodium sulphite . .	2 oz.	200 g.
Water . . .	5 ,,	500 ccs.
Dissolve and add—		
Edinol . . .	½ oz.	50 g.
Sodium carbonate .	2½ ,,	250 ccs.

and then add water to make 10 oz. This forms a concentrated developer, and for use is diluted with from five to ten times its volume of water.

Two-solution

A.	Sodium sulphite	2 oz.	100 g.
	Edinol	96 grs.	10 ,,
	Water to	20 oz.	1,000 ccs.
B.	Sodium carbonate	10 % sol.; or	
	Potassium carbonate	5 % sol.	

Use equal parts of A and B. Sodium carbonate works slowly, and for quicker working potassium carbonate may be substituted for it. (For use combined with hydroquinone, *see* "Developers, Mixed.")

EDISON'S KINETOSCOPE (*See* "Kinetoscope.")

EDWARDS'S FORMULÆ

These include a one-solution intensifier made up from the following:—

A.	Mercuric chloride	60 grs.	3·9 g.
	Water	8 oz.	227 ccs.
B.	Potassium iodide	180 grs.	11·7 g.
	Water	2 oz.	57 ccs.
C.	Sodium hyposulphite	120 grs.	7 g.
	Water	2 oz.	57 ccs.

When all are dissolved add A to B, shake well and add C; allow to stand for an hour or two before use. Soak the negative in this until intensified, and then immerse in a "hypo" fixing bath for half a minute, finally washing well. If local intensification is required, the solution may be applied to the parts with a camel-hair mop or a pad of cotton-wool. Edwards's reducer or clearing bath is used chiefly for removing yellow stains from negatives that have been developed with pyro. The formula is:—

Alum	1 oz.	55 g.
Ferrous sulphate	3 ,,	165 ,,
Sulphuric acid	1 drm.	6·25 ccs.
Water	20 oz.	1,000 ,,

This gives an apple-green solution, which is used after fixing and washing. It keeps well if the used liquid is not returned to the stock solution. Another formula due to Edwards is given under the heading "Redeveloper."

EFFECT (Fr., *Effet*; Ger., *Wirkung*)

The general impression given by a print apart from any examination of its details. It depends mainly on the disposition of its principal masses and its chiaroscuro (*which see*).

EFFLUVIOGRAPH

An invention by Mons. Tommasi, in 1886, by the use of which all the effects of photography were obtained through the electric effluvia or obscure discharge. Two metal brushes, placed parallel in front of one another, were each connected to the pole of a Holtz machine. A dry plate of about the same height was placed perpendicularly to the brushes; and on the discharge taking place in darkness an image was obtained by radiations.

The term effluviography is sometimes applied to images obtained by what is more commonly known as vapography (*which see*).

EGG, WHITE OF (Fr., *Blanc des œufs, Albumine*; Ger., *Frisches Eiweiss, Albumin*)

Commonly referred to in photographic processes as albumen (*which see*). First used for coating glass plates by Niepce de Saint-Victor in 1848. About 1866 it was largely used for albumenised paper, and one maker stated at the time that he broke 2,000 eggs daily, merely to obtain the whites. Mayall, whose albumen negative process was widely used, stated that the white of a duck's egg is more sensitive than that of a hen's egg, and that the white of a goose's egg was more sensitive than either.

In process work the whites of eggs are largely used for making up the albumen-bichromate solution in preference to dried albumen.

EGYPTIAN VIGNETTES (*See* "Black Vignettes.")

EIKONOGEN (Fr., *Iconogène*; Ger., *Eikonogen*)

A developer introduced by Dr. M. Andresen in 1889; it appears in a yellowish white powder or yellowish crystals when fresh, but rapidly changes to a brownish tinge. Its formula is $C_{10}H_5$ (OH) NH_2 SO_2 ONa. It is sparingly soluble in water, but readily so in the presence of alkalis, especially when heated. It can be used in a one-solution or a two-solution form, and is suitable for all kinds of plates and bromide and gaslight papers. It is widely advocated for very rapid exposures, for which the following one-solution mixture, which is ready for use, is particularly suitable:—

Eikonogen	100 grs.	20 g.
Sodium sulphite	200 ,,	40 ,,
Sodium carbonate	100 ,,	20 ,,
Potassium bromide	5 ,,	1 ,,
Water	10 oz.	1,000 ccs.

The small quantity of bromide added appears to increase the density of the negative, but where there is a suspicion of under-exposure, and when soft portrait negatives are desired, it is better omitted. Bromide acts very powerfully with eikonogen, and further additions in cases of over-exposure should be made cautiously. The following is the formula for the two-solution form:—

A.	Eikonogen	1 oz.	50 g.
	Sodium sulphite	4 ,,	200 ,,
	Water	20 ,,	1,000 ccs.
B.	Sodium carbonate	3 ,,	150 g.
	Water	20 ,,	1,000 ccs.

For use, mix 1 part of A, 1 part of B, and 2 parts of water. Potassium carbonate may be used in place of the sodium in the B solution, and a more energetic developer obtained. When eikonogen is used for wet plates they generally need to be intensified, preferably with pyro-silver. (For an eikonogen-hydroquinone combination, *see* "Developers, Mixed.")

EIKONOGEN PRINTING PROCESS

A process invented in 1895 by A. Frey, of Paris. Aniline, or toluidine, is treated with sulphuric acid, and the almost colourless product is dissolved in warm water. A mixture of this solution with eikonogen, applied to albumen paper, gives a reaction on exposure to light. Cherry or blackberry juice is bleached by mixing with eikonogen solution, but when paper coated with the mixture is exposed to light the colour returns. In the same way, several iron, copper, and tin salts, when mixed with eikonogen, are

CHURCH OF NOTRE DAME, CAUDEBEC-EN-CAUX By H. W. Bennett, F.R.P.S.

ARCHITECTURAL PHOTOGRAPHY (Exterior)

sensitive to light. Freshly prepared potassium formate with eikonogen also yields a sensitive substance.

EIKRONOMETER (Fr., *Eikronomètre ;* Ger., *Eikronometer*)

An early form of the Watkins dark-room clock. (*See* "Clock, Dark-room.")

ELECTRIC INKLESS PRINTING

A process invented by W. Friese-Greene, in which the electric current was made to pass through the type forme and the impression cylinder of an ordinary letterpress printing machine. The paper was treated chemically, probably with an iron salt, and when impressed on the type was darkened by the electric action.

ELECTRIC LIGHT (Fr., *Lumière électrique ;* Ger., *Elektrisches Licht*)

The electric light is the most practically useful artificial illuminant for photographic purposes. Where public mains are not accessible, a small dynamo, driven by a gas-engine, offers the most convenient means of installation. Apart from the initial expense of the dynamo and engine, this is naturally more economical than the public supply, though involving greater trouble and attention. The switches should be such as will stand hard wear and rough usage, and an adjustable resistance is an advantage. There are four principal types of lamps—the arc, the incandescent or glow lamp, the Nernst lamp, and the mercury vapour lamp. In portraiture, the arc lamp is most used. For studio employment and for ordinary black-and-white copying, the enclosed arc is best, but for photographing colour the open arc is superior. These two patterns are fully dealt with under the heading "Arc Lamps." Flame arc lamps, in which a brilliant golden yellow light is obtained by incorporating metallic salts in the carbons, or by introducing a central core of such salts, have also attracted some attention among photographers, it having been stated that colour values are better reproduced with them. A plate sensitised for yellow has, of course, to be employed. An arc lamp in use should not be examined or adjusted without a piece of smoked yellow glass before the eyes, or goggles of the same material.

The incandescent glow lamp is yellower and less actinic than the arc, but a number of these suspended inside a dead white spherical or parabolic reflector, having a muslin diffusing screen in front, can be used for portrait work, giving a soft and pleasing lighting. Several lamps of this kind are on the market. Ruby and orange glow lamps are much used in the dark-room. The new metallic filament lamps have greatly improved the efficiency of incandescent electric lighting, yielding better illumination with less current than carbon filament lamps.

The Nernst lamp makes use of a thread of yttrium and zirconium oxides, and similar metallic earths. These lamps are employed with the optical lantern and for enlarging ; they are economical of current and carry their own resistances.

The mercury vapour lamp is dealt with under its own heading. It requires very little current, and is a useful light for printing, copying, or enlarging. A certain prejudice exists against its employment in portraiture owing to its unpleasant colour, due to the absence of red rays, but this is easily remedied by using one or two ruby glow lamps in addition.

For copying, etc., the nearness with which the lamp can be placed to the easel is of importance from an economical standpoint, other considerations being equal. Thus, the enclosed arc can be brought closer than the open arc, the flame arc still nearer, and the mercury vapour lamp nearest of all.

In process work, the electric arc light is invariably used for copying in preference to daylight. (*See* "Arc Lamps.") Mercury vapour lamps are also used to some extent. Incandescent electric lamps are not sufficiently powerful.

ELECTRIC LIGHT FOR OPTICAL LANTERN (*See* "Optical Lantern.")

ELECTRIC RADIATIONS (*See* "X-ray Photography.")

ELECTRIC TELEPHOTOSCOPY (*See* "Transmission of Photographs Electrically.")

ELECTRO

A common abbreviation of the term "Electrotype" (*which see*).

ELECTRO ETCHING

Numerous processes have been put forward at various times for etching by means of the electric current, but none has come into regular commercial use. The earliest was a method of etching the daguerreotype plate. Fizeau gilded the image by depositing gold upon it, and then etched the parts not covered by the gold, which acted as a resist. Grove, Donne, and others produced engraved plates in this manner, performing the etching by galvanic action, but the difficulty of biting the delicate daguerreotype image to a sufficient depth and obtaining the requisite ink-holding grain soon led to the abandonment of the method. Prof. Jacobi, in 1839, engraved line plates into relief by electric etching, and about the same time Thomas Spencer, of Liverpool, described a process of galvanic etching by coating copper plates with a resist ground and scratching lines through it. In later times J. W. Swan used electric etching for photogravure plates. Images scratched with needle-points through an etching ground have often been successfully etched. Sanger Shepherd some years ago described a process of etching a bitumen print on copper by depositing gold on the parts laid bare by development and etching the other parts. Dr. Strecker has patented a process for electric etching with the solution of a zinc salt. Zinc, copper, and steel have been successfully etched, but the process is slower than ordinary etching, and does not appear to have any advantages.

ELECTROGRAPH (Fr., *Électrographe ;* Ger., *Elektrograph*)

An apparatus for the telegraphic transmission of photographs, invented conjointly, in 1901, by H. R. Palmer, M. E. T. Mills, and Dr. W. P.

Dunlany. The receiving and transmitting machines are identical in construction, and may be used alternatively. The transmitter carries a zinc enlargement of a half-tone plate, curved to fit a cylinder, the depressed or etched portions of the plate being filled with an insulating material. Over the cylinder a stylus is made to travel, much after the manner of a phonograph stylus. At the other end of the wire, the receiving cylinder is fitted with a pen, which travels at the same rate as the transmitting stylus over a sheet of paper placed beneath. When the stylus is in contact with metal the circuit is completed, and the pen of the receiving instrument traces a dot or line corresponding with that on the zinc plate; but when the stylus touches the insulating material in the etched portions the circuit is broken, and no mark is made by the pen. As a consequence, the picture on the half-tone plate is reproduced at the receiving end, and from the copy a smaller plate, suitable for press use, may be made by reduction in the usual manner. Each instrument is provided with a pen as well as a stylus, and either may be used at will.

ELECTROGRAVURE

A process invented by Jos. Rieder for etching on steel by galvanic means. It was shown at the Paris Exhibition of 1900.

ELECTROLYTIC BREAK (*See* "Contact Breaks.")

ELECTRO-PHOTOTYPY

A name given to Sutton's process (not used commercially) of making half-tone printing blocks. A half-tone negative was made by photographing through a ruled screen on to a gelatine plate. After being developed, and before it was completely dry, the plate was heated, this having the effect of swelling the dots into high relief. The plate was then used as a mould for electrotyping.

ELECTROTINT

A fancy name given to the half-tone process by an American firm.

ELECTROTYPE (Fr., *Électrotype, Galvano;* Ger., *Galvano, Galvanische Riederschlag*)

A copy or reproduction of a relief surface made by the electrotyping process.

ELECTROTYPING (Fr., *Electrotypage, Galvanoplastie;* Ger., *Galvanoplastik*)

A process by which engraved plates, type formes, etc., are reproduced. They are pressed into a layer of beeswax, the resulting mould is blackleaded by brushing or by spraying with a solution of blacklead, to make the surface conductive, and the mould is then suspended in a solution of copper sulphate, a copper plate being suspended opposite and near to the mould to form an anode. The two are connected to a source of electric current, and copper is then deposited in a thin shell on the mould until thick enough to be stripped off. This shell is filled up at the back with type metal to give it sufficient thickness and solidity, and after being planed at the back and mounted on a wood or metal block is ready for printing from.

Photographic reliefs in gelatine have also been electrotyped. (*See* "Swelled Gelatine Process.")

The late G. Scamoni, of St. Petersburg, succeeded in electrotyping from the image of a wet collodion negative. Nickel, nickel steel, iron, brass, and other metals have also been successfully deposited by electrotyping. In the Ordnance Survey Office, Southampton, original engraved maps are reproduced by electrotyping. The copper plate is silvered to prevent the copper from adhering, and a thick shell is deposited. This is in relief, and forms the matrix from which any number of duplicates may be made. The matrix is silvered and deposited on in the same way as upon the original. Major-General Waterhouse, when at the Survey of India, successfully electrotyped from a photographic carbon image developed on the copper plate. (*See also* "Daguerreotypes, Electrotyping.")

ELECTROTYPY

A process of reproducing daguerreotypes by electro-deposition.

ELECTRO-ZINCOGRAPHY

A process of engraving on zinc in which the electric current is used.

ELEMENT (Fr., *Élément;* Ger., *Element*)

This term has been applied by chemists to those substances which cannot, by any known means, be split up into other and simpler forms of matter. The following table is a list of them, with the symbol and atomic weight of each. The symbol, it may be explained, is the chemist's shorthand or grammalogue, whilst the atomic weight is that in which each element combines with others to form salts or compounds. Thus the chemist writes $AgNO_3$ for silver nitrate, and this formula means that there are 108 parts of silver, 14 parts of nitrogen, and 48 parts of oxygen combined to form 170 parts of silver nitrate. If now it is wished to form silver bromide from this, using potassium bromide, the equation or shorthand for the decomposition which would occur would be written:—

$$\underbrace{AgNO_3}_{108,14,48} + \underbrace{KBr}_{39,80} = \underbrace{AgBr}_{108,80} + \underbrace{KNO_3}_{39,14,48}$$

$$170 + 119 = 188 + 101$$

and this shows that 119 parts of potassium bromide would be required to convert 170 parts of silver nitrate, and the result would be 188 parts of silver bromide, with 101 parts of potassium nitrate as a by-product; and no matter what actual weight of silver nitrate was used, the combination would always take place in the above ratio—170 : 119.

Name	*Symbol*	*Atomic weight*
Aluminium	Al	27
Antimony (Latin: *Stibium*)	Sb	120
Arsenic	As	75
Barium	Ba	137
Beryllium	Be	9·1
Bismuth	Bi	208
Boron	B	11
Bromine	Br	80
Cadmium	Cd	112

Name	*Symbol*	*Atomic weight*
Cæsium	Cs	133
Calcium	Ca	40
Carbon	C	12
Cerium	Ce	140
Chlorine	Cl	35·5
Chromium	Cr	52
Cobalt	Co	59
Copper (Latin: *Cuprum*)	Cu	63
Didymium	Di	142
Erbium	E	166
Fluorine	F	19
Gallium	Ga	70
Germanium	Ge	72·3
Gold (Latin: *Aurum*)	Au	197
Helium	He	4
Hydrogen	H	1
Indium	In	113
Iodine	I	127
Iridium	Ir	193
Iron (Latin: *Ferrum*)	Fe	56
Lanthanum	La	138
Lead (Latin: *Plumbum*)	Pb	207
Lithium	Li	7
Magnesium	Mg	24
Manganese	Mn	55
Mercury (Latin: *Hydrargyrum*)	Hg	200
Molybdenum	Mo	96
Nickel	Ni	59
Niobium	Nb	94
Nitrogen	N	14
Osmium	Os	195
Oxygen	O	16
Palladium	Pd	106
Phosphorus	P	31
Platinum	Pt	193·4
Potassium (Latin: *Kalium*)	K	39
Rhodium	Rh	104
Rubidium	Rb	85
Ruthenium	Ru	103·5
Samarium	Sa	150
Scandium	Sc	44
Selenium	Se	79
Silicon	Si	28
Silver (Latin: *Argentum*)	Ag	108
Sodium (Latin: *Natrium*)	Na	23
Strontium	Sr	87·5
Sulphur	S	32
Tantalum	Ta	182
Tellurium	Te	125
Thallium	Tl	204
Thorium	Th	232
Tin (Latin: *Stannum*)	Sn	118
Titanium	Ti	48
Tungsten (Latin: *Wolfrunium*)	W	184
Uranium	U	240
Vanadium	V	51
Ytterbium	Y	173
Zinc	Zn	65
Zirconium	Zr	90

The Latin names in brackets are included to show the derivation of the symbols. Only the atomic weights generally used are given, as these are continually under revision, and some are still in doubt, although only to the first or second place of decimals. The newer gases and some of the latest discovered elements — such as radium, etc.—are not included.

ELEMI (*See* "Gums and Resins.")

ELIMINATORS (*See* "'Hypo' Eliminators.")

ELLIOTYPE

A process of painting a picture upon glass, in body and transparent colours, and printing therefrom as though it were an ordinary negative; named after its introducer. It was never largely used, and is now obsolete.

EMERY (Fr., *Émeri;* Ger., *Schmirgel*)

An exceedingly hard mineral, varying slightly in colour, a compact variety of corundum, and very generally regarded as an iron ore. Chemically it consists of alumina, silica, and iron. Its chief source is the Isle of Naxos. It is reduced to powder and used for grinding and polishing metal, glass, etc. Opticians use it for the first rough grinding of lenses. Square sticks of emery, called emery files, are sometimes used by wet collodion workers for taking the sharp edge off glass plates; but carborundum sticks have been found better. Emery is sometimes used in the form of a very fine powder instead of pumice powder for cleaning copper and zinc; and collotype workers grind the surface of their thick glass printing plates with fine emery to give a matt surface to which the film can adhere.

EMETICS (*See* "Poisons and Their Antidotes.")

EMISSION, NODE OF (*See* "Nodal Points.")

EMULSION (Fr., *Émulsion;* Ger., *Emulsion*)

A liquid, usually viscous, containing in suspension an insoluble body in an extremely finely divided state. Plates, films, and bromide, gaslight and printing-out papers are coated with emulsions. To such perfection has the commercial manufacture of these articles attained that it will hardly pay the average worker to prepare his own; but from an educational point of view the manufacture of emulsions is extremely valuable. In the following notes only tested formulæ are given, and it must be clearly understood that perfection is only attainable after considerable experience, and the tyro must not expect to prepare either papers or plates as excellent or as fast in working as those commercially obtainable.

The various stages in emulsion making will be outlined, and the reasons for each step explained. Let it be assumed, therefore, that it is wished to make a silver bromide gelatine emulsion. The bromide is formed by double decomposition or chemical interchange between an alkaline bromide, usually potassium or ammonium, and silver nitrate. If aqueous solutions of these two salts were mixed in a haphazard fashion there would certainly be obtained a coarse, granular form of silver bromide which would at once sink to the bottom of the vessel, and there might be an excess of either silver nitrate or bromide. To prevent the immediate deposition of the bromide,

and to obtain a fine grain, a vehicle—gelatine—is added to the alkaline bromide solution, and the fineness of grain largely depends upon the proportion of gelatine used. If too much gelatine, or too hard a kind, be used during mixing it is difficult to obtain high speed, as the gelatine acts as a mechanical restrainer; on the other hand, if too little is used, a coarse granular deposit is formed, and the emulsion tends to fog and thinness. When an alkaline bromide and silver nitrate are mixed together they combine in definite proportions according to their molecular weights. The molecular or combining weight of potassium bromide is 119, and that of silver nitrate is 170. If these quantities were weighed out exactly, whether in grains, ounces, pounds, or tons, or grammes or kilogrammes, exactly 188 parts of silver bromide would be formed, and there would be found in the water neither silver nitrate nor potassium bromide; but the slightest error in weighing might give an excess of silver nitrate, which would be fatal to the emulsion in development. It is customary, therefore, to use an excess of bromide or other salt in all emulsions intended for development; this excess varies in most formulæ, and is governed by the process used, the quality of the gelatine and the speed required. Some gelatines will give perfectly clean emulsions with a much smaller excess than others. Then, as one of the prime uses of the excess of bromide is to keep the emulsion free from fog, a reasonable excess is useful on this account, and increase may make an otherwise foggy-working formula satisfactory. Of recent years it has been considered that an increased excess of bromide tends to give faster emulsions for negative work, but it has at the same time a tendency to produce thinness in the high lights. A normal ratio is 100 of silver nitrate to 80 of potassium bromide, though it will be seen that the ratios given in the formulæ vary from this in some cases.

When first mixed the emulsion is very slow, no matter what formula is used, and would be quite unsuitable for anything but lantern plates. It is therefore subjected to a "ripening" process, either by continued application of heat or the use of ammonia. Exactly what occurs during ripening is a matter of doubt, but it is generally assumed that the silver bromide grain increases in size and that this increase is accompanied by greater sensitiveness to light; the change is probably more of a physical than chemical nature.

It has been already stated that there is a chemical interchange between the silver nitrate and bromide, and this is represented by the following equation, which may be said to be the chemist's shorthand method of explaining what occurs :—

$AgNO_3$	+	KBr	=	AgBr	+	KNO_3
silver nitrate		pot. bromide		silver bromide		pot. nitrate
170		119		188		101

The figures here are the molecular or combining weight, and, as has already been explained, 170 parts of silver nitrate combine with 119 of potassium bromide to form 188 parts of silver bromide and 101 parts of potassium nitrate. Alkaline nitrate thus formed must be got rid of, and this is the purpose of the washing, which also removes the excess of alkaline bromide and the ammonia, if this latter has been used for ripening. Were these salts not washed out they would crystallise out on the plate during the process of drying after coating, and either prevent the access of light, or give rise to crystalline markings which would show in the negative.

There are two distinct systems of making emulsions: the acid or boiling process and the ammonio-nitrate process. The former, as a rule, is used for somewhat slow emulsions, and the latter for the faster negative kinds. As to the highest speed obtainable by the acid process, no definite data are available, but certainly 200 H. and D. may be considered the limit, whilst by the ammonia process from 300 to 400 H. and D. can be reached. In the acid process the mixing and the ripening are effected in an acid gelatine solution, whilst in the other process either the whole or part of the silver nitrate is converted into ammonio-nitrate of silver. For amateur work the ammonia process is somewhat easier, and, if excessive speed is not required, nice clean emulsions, giving good density, can be obtained.

Before treating further on the actual mixing of the emulsion, it should be stated that the

TABLE I

	Molecular Weights	*Weight of $AgNO_3$ required to convert 1 gr. of alkaline haloid*	*Weight of soluble haloid required to convert 1 gr. $AgNO_3$*	*Weight of silver haloid produced by 1 gr. soluble haloid*	*Weight of soluble haloid required to produce 1 gr. silver haloid*	*Weight of silver haloid produced from 1 gr. of $AgNO_3$*
Ammonium bromide	98	1·734	·576	1·918	·521	1·106
Potassium bromide	119	1·427	·700	1·578	·633	
Sodium bromide	103	1·620	·606	1·825	·548	
Ammonium chloride	53·5	3·177	·315	2·682	·373	·844
Sodium chloride	58·5	2·906	·344	2·453	·408	
Ammonium iodide	143	1·172	·853	1·620	·617	1·382
Potassium iodide	166	1·023	·977	1·415	·707	
Sodium iodide	150	1·133	·882	1·566	·638	

alkaline bromides and iodides are interchangeable, though as a rule that given in a formula should be adhered to; still, the accompanying tables, compiled by Ackland, will be found exceedingly useful, as they allow of the easy calculation of the necessary amount of haloid for any quantity of silver, or the substitution of one for another.

Table I. enables the worker to calculate the weight of haloid to convert any given quantity of silver, or, vice versa, the quantity of silver haloid produced from every grain of haloid, or the weight of silver haloid produced from every grain of silver nitrate. If, for instance, the formula is :—

Potassium bromide . .	150
Potassium iodide . .	10
Ammonium chloride . .	25
Gelatine	200

The quantity of silver required to saturate the above can be calculated by taking the figures in the third column and multiplying by the above. Thus :—

Potassium bromide	150 × 1·427 =	214·05
Potassium iodide	10 × 1·023 =	10·23
Ammonium chloride	25 × 3·177 =	79·425
Weight of silver nitrate required		303·705

The fourth column enables the worker to calculate readily what excess of soluble haloid there may be present in the emulsion; whilst columns 5, 6, and 7 enable him to work back when he has determined on a fixed content of silver haloid.

Table II. is extremely useful for finding the weight of one haloid that will replace another. Supposing, for instance, that it is desired to replace 80 grs. of ammonium bromide with the sodium salt; then in the first vertical column headed "ammonium bromide" there will be found against sodium bromide 1·051, which is the weight of this salt that will convert as much silver nitrate as one grain of ammonium bromide. Therefore 1·051 × 80 = 84·08 would be the quantity of sodium haloid to use.

Before entering into the making of emulsions it may be as well to consider the subsequent operations first, as they play an important part in the quality of the finished emulsion. The method adopted for setting the emulsion has considerable influence on the final result, both as regards speed and density. If the speed required is approximately obtained in the first process of cooking, then pouring out the emulsion into flat pans to the depth of about 1 in. will quickly arrest the ripening action, especially if the pan or dish is stood in cold running water. In summer-time it is even advisable to pack ice around the pan, which for such small quantities as given in these pages may be a clean (most important) 15-in. by 12-in. dish. On the other hand, if the emulsion is allowed to set in its mixing pot, greater speed is obtained, especially when ammoniacal emulsions are made, because the heat is longer retained, and there is less chance for the escape of the ammonia. It is as well, however, in this case to cool the bulk of the emulsion by running cold water around the pot and constantly stirring; ice water, too, may be used, but care must be exercised, as when an emulsion is poured out into flat, ice-cooled pans to set there is danger in the case of negative emulsions of a want of density in the highest lights.

Still more important with regard to the density and speed of the emulsion is the lapse of time between the setting and washing; and in the case of negative emulsions the speed may be nearly doubled, and consequently the density of the high lights increased, by allowing the emulsion to stand in the solid state in cold for twenty-four to forty-eight hours. Except where otherwise advised, the normal time is about twelve hours; that is to say, a negative emulsion made one evening is ready the next morning to be broken up and washed.

The easiest method of breaking up small quantities of emulsion is to use coarse-meshed canvas, the mesh being about ¼ in. square. The emulsion should be coarsely cut up by means of a silver knife (do not use a steel one), or scored through with a wide-pronged silver or plated fork, and then put into a sheet of the canvas, the ends of the latter being gathered together so as to form a bag. The bag is held under the surface of a dish of clean water and squeezed round and round so as to force the emulsion through the mesh. Failing the canvas, a fork can be efficiently used if the emulsion has been set in a dish, as it can be scored longitudinally and then across at right angles so as to cut it up into little cubes, which should not be too small, as otherwise they pick up too much water.

TABLE II

	Ammonium bromide	*Potassium bromide*	*Sodium bromide*	*Ammonium chloride*	*Sodium chloride*	*Ammonium iodide*	*Potassium iodide*	*Sodium iodide*
Ammonium bromide . . .	1	·823	·951	1·832	1·675	·676	·59	·653
Potassium bromide . . .	1·215	1·	1·156	2·226	2·036	·821	·717	·794
Sodium bromide	1·051	·865	1·	1·925	1·761	·71	·62	·684
Ammonium chloride . . .	·546	·449	·519	1·	·914	·369	·322	·356
Sodium chloride	·597	·491	·568	1·093	1·	·403	·352	·39
Ammonium iodide . . .	1·479	1·217	1·408	2·712	2·478	1·	·873	·966
Potassium iodide . . .	1·695	1·394	1·612	3·104	2·839	1·145	1·	1·107
Sodium iodide	1·53	1·259	1·456	2·803	2·564	1·034	·903	1·

Commercially, when large quantities of emulsion have to be treated, a power or hand press is used, and the emulsion forced through a perforated plate.

After shredding, the emulsion is washed. According to the quantity to be treated, washing may be effected either in flat trays or by means of a calico or linen bag and a deep jar. In the first case, a sheet of linen should be placed over the dish or tray, and the emulsion placed in it and a stream of water allowed to run in at one corner and out at the diagonally opposite corner; it is as well to raise slightly that end of the dish at which the water flows in. In the case of the bag method a square of linen should be gathered up into a bag, the emulsion placed therein, and some stout string tied round with a sufficiently long loop to pass over a stick that rests on the mouth of the jar and allows the bag to hang down in the water. By this method the soluble and detrimental salts formed in the emulsion diffuse out into the water. Whichever method is adopted, it is important that the water should be frequently changed, and it is advisable to squeeze the emulsion gently at intervals so as to press out the water.

There is great diversity of opinion as to the best duration of washing, some workers maintaining that from eight to twelve hours is not too long, whilst others reduce the time to two hours or even less. The disadvantages of prolonged washing are that the emulsion, particularly in hot weather, picks up a large quantity of unnecessary water which, unless an extra quantity of gelatine is added afterwards, renders the emulsion so sloppy that it is difficult to coat it on glass, and, further—particularly with rapid negative emulsions—the ripening process goes on, and as the soluble bromides in excess are being removed, there is great danger of fog ensuing. From very careful tests the writer has found that all emulsions can be thoroughly washed by repeated changes (about twelve) of water in two hours, and small quantities—particularly if the weather is warm—can be thoroughly washed in one hour. The washed emulsion should be allowed to drain well, and is then ready for melting.

The emulsion shreds should be placed in a pot in a water bath at 90° F. (about 32° C.) and the temperature gradually raised to 120° F. (nearly 49° C.), at which temperature the final quantity of gelatine should be added and the whole well stirred till the gelatine is dissolved. It is just as well to keep the emulsion at this temperature for at least half an hour, and it can then be filtered through clean felt jelly-bags, or, failing these, swansdown calico or Canton flannel, previously washed to remove any dressing. If there is any difficulty in getting the emulsion to pass through the material, pressure may be applied by squeezing with the hands, but usually, with the emulsion at the temperature stated, there is no trouble providing the filter is first wetted with hot water and well wrung out.

GELATINO-CHLORIDE OR P.O.P. EMULSION.—The simplest form of gelatine emulsion is that used for P.O.P., and the following formulæ will give excellent results:—

Valenta's Formula

A.	Silver nitrate .	307 grs.	32 g.
	Citric acid .	77 ,,	8 ,,
	Hot distilled water .	3 oz.	160 ccs.
B.	Hard emulsion gelatine . .	922 grs.	96 g.
	Distilled water .	14 oz.	700 ccs.

Allow to soak for half an hour, and then melt in a water bath at 120° F. and add—

C.	Ammonium chloride.	28 grs.	2·8 g.
	Tartaric acid . .	28 ,,	2·8 ,,
	Sodium bicarbonate	14 ,,	1·4 ,,
	Alum . .	18 ,,	1·8 ,,
	Distilled water .	3 oz.	140 ccs.

The ingredients in solution C must be dissolved in the order given, and care should be taken to use a sufficiently large vessel, as brisk effervescence ensues. Both B and C should be brought to 120° F. (nearly 49° C.) and mixed, and then A, at the same temperature, added slowly and with constant agitation. Allow the emulsion to stand for from two to four hours in a water bath at 110° F. (about 43° C.) with occasional stirring, and then add—

Alcohol . . .	15 drms.	100 ccs.

and filter through glass wool or two thicknesses of Canton flannel or one thickness of swansdown. Care must be exercised as to the light used, as the fluid emulsion can readily darken in colour whilst digesting even in strong gaslight. The duration of digestion or ripening is dependent on the speed required. If coated when freshly mixed, the emulsion is slow and gives rich and vigorous prints; if, on the other hand, it is ripened for four hours it becomes much more rapid, and gives a longer scale of gradation. If it is desired to obtain a paper that will keep for some time without discoloration, an equal quantity of citric acid to that given above should be added after digestion.

Another excellent formula is the following:—

Wade's Formula

A.	Ammonium chloride.	25 grs.	2·6 g.
	Rochelle salts .	25 ,,	2·6 ,,
	Alum . .	50 ,,	5·2 ,,
	Distilled water	2½ oz.	125 ccs.

Dissolve, and add—

B.	Gelatine . .	820 grs.	86 g.
	Distilled water	15 oz.	750 ccs.

previously dissolved at 110° F., and finally add—

C.	Silver nitrate .	284 grs.	30 g.
	Citric acid .	150 ,,	15·6 ,,
	Distilled water	2½ oz.	125 ccs.

The coating temperature of the above emulsions should be about 95° F. (35° C.).

If an emulsion suitable for extremely thin, flat negatives is required, the addition of a small quantity of the chloride of uranium, of nickel or of cobalt, to any of the above formulæ will shorten the scale of gradation, but the most satisfactory agent is calcium chromate, which must be added with caution, as it is extremely energetic in its action, 0·1 per cent. reducing the scale of gradation by about one-third.

For matt surface papers the quantity of gelatine should be reduced so as to make an 8 per

cent. solution. More satisfactory matt emulsions can be obtained by incorporating with the emulsion 10 per cent. of fine rice starch. The necessary quantity of starch should be rubbed into a cream with a little water and a small quantity of gelatine, taken from the emulsion itself, and the whole should be heated to 160° F. (71° C.) for an hour and then added to the emulsion. (*See also* "Collodion Emulsion.")

EMULSIONS FOR DEVELOPMENT

These may be divided into those for positive work and those for negative work.

Positive Emulsions

Positive emulsions may again be subdivided into chloride and bromide emulsions, the former including chloro-bromide also, and such as are suitable for gaslight papers and plates.

Chloride Emulsion (Eder)

A.	Sodium chloride	288 grs.	30 g.
or	Ammonium chloride	264 ,,	27·5 ,,
	Hard gelatine	384 ,,	40 ,,
	Distilled water	8 oz.	400 ccs.
	Hydrochloric acid	5 drops	10 drops
B.	Silver nitrate	576 grs.	60 g.
	Distilled water	2 oz.	100 ccs.
C.	Hard gelatine	384 grs.	40 g.
	Distilled water	10 oz.	500 ccs.

Dissolve C by heating to 120° F. (nearly 49° C.), and add B at the same temperature; then add A, also at 120° F., and allow to stand at this temperature for ten minutes; then rapidly cool and set. This emulsion yields a satisfactory gaslight paper or plate, which readily gives warm tones. If the hydrochloric acid is omitted, and 240 grs. or 25 g. of citric acid is added, very warm tones, from yellow to reddish brown, are more easily obtained. If the above emulsion is cooled down to 95° F. (35° C.) immediately after mixing, and 60 minims or 6 ccs. of liquor ammoniæ (·880), and 2 oz. or 100 ccs. of distilled water are gradually added with constant stirring, a much more rapid emulsion is obtained, which gives black tones more readily.

The great trouble in mixing all chloride and chloro-bromide emulsions is the formation of a coarse grain, which is reduced by the developer without exposure to light. For this reason the beginner is advised to modify the above formula as follows: Add the whole of the gelatine to A and increase the quantity of water to 12 oz. or 600 ccs., and add the silver nitrate dry, in small quantities at a time, with vigorous stirring. When all the silver is added continue stirring for fifteen minutes, and then add 8 oz. or 400 ccs. of distilled water. As an alternative the emulsion may be set and washed as usual, and then the extra quantity of water added. Either way, there is less chance of the occurrence of coarse grain, and the results are equally satisfactory.

There is but little difference in the final result whether the sodium or ammonium chloride be used; the former gives a little more contrast. Much harder working emulsions can be obtained by adding to the above quantity of chlorised gelatine 1·25 grs. or ·05 g. of pure copper chloride; or greater contrasts may be obtained by increasing this still further.

For some gaslight papers an unwashed emulsion is used, but there is far greater liability to the formation of black spots.

Chloro-bromide Emulsions

Emulsions containing both bromide and chloride of silver are more sensitive than pure chloride emulsions, and whilst giving warm tones with increased exposure, they give better blacks, there being less tendency to greenish tones. The ratio of bromide to chloride is a matter of taste, but the more chloride the less the gradation, and the more bromide the faster the emulsion.

Wratten's Formula

Nelson's No. 1 gelatine	40 grs.	200 g.

rinse two or three times in water and add to—

Distilled water	4 oz.	856 ccs.

Dissolve at 125° F. (nearly 52° C.) and add—

Ammonium bromide (neutral)	110 grs.	55 g.
Sodium chloride	30 ,,	15 ,,
Hydrochloric acid (10% solution)	10 mins.	5 ccs.

Then add in a fine stream—

Silver nitrate	200 grs.	100 g.
Distilled water	1 oz.	220 ccs.

with constant stirring. Digest for ten minutes at 150° F. (65·5° C.), and add—

Hard gelatine	175 grs.	87·5 g.

which has been previously washed and soaked in water for half an hour and well drained. When the gelatine has melted, set, and wash for half an hour with six changes of water, drain well and melt, and make the total bulk up to 1,750 ccs. by adding water. Finally add—

Tannin	1·03 g.

Wellington's Formula

Potassium bromide	384 grs.	40 g.
Sodium chloride	192 ,,	20 ,,
Citric acid	960 ,,	100 ,,
Hard gelatine	1,344 ,,	140 ,,
Distilled water	20 oz.	1,000 ccs.

Heat to 150° F. (65·5° C.), and add—

Silver nitrate	960 grs.	100 g.
Distilled water	20 oz.	1,000 ccs.

heated to 150° F. Digest for ten minutes, and pour out into a dish to set.

Valenta's Formula

No. I.:—

Ammonium bromide	480 grs.	50 g.
Ammonium chloride	48 ,,	5 ,,
Nitric acid	10 drops	20 drops
Hard gelatine	1,615 grs.	168 g.
Distilled water	26 oz.	1,333 ccs.

Heat to 130° F (54·4° C.), and add—

Silver nitrate	960 grs.	100 g.
Distilled water	26 oz.	1,333 ccs.

also at the same temperature. Allow to digest one hour, and then pour out and set.

No. II., for greater contrasts:—

The above formula with—

Ammonium bromide	50 grs.	5·2 g.
Ammonium chloride	300 ,,	30 ,,

In mixing both the Wellington and Valenta formulæ the same procedure may be adopted as for Wratten's.

The ratio of the silver haloids in these three emulsions is as follows:—Wratten—chloride 1, bromide 2·1; Wellington—chloride 1, bromide 1·7; Valenta No. I.—chloride 1, bromide 8·7; Valenta No. II.—chloride 7, bromide 1. Wellington's gives very warm tones more easily than the others with increased exposures.

Lantern Plate and Bromide Paper Emulsions

These may be pure bromide emulsions, but it is preferable to use bromo-iodide, as the iodide tends to keep the whites free from fog. Some commercial bromide papers are also chlorobromide emulsions. The following gives a very satisfactory but slow emulsion, either with or without the iodide.

Ammonium bromide	672 grs.	70 g.
Potassium iodide	15·3 ,,	1·6 ,,
Hard gelatine	2 oz.	150 ,,
Hydrochloric acid (10% solution)	144 mins.	15 ccs.
Distilled water	30 oz.	1,500 ,,

Heat to 110° F. (about 43° C.), and add—

Silver nitrate	960 grs.	100 g.
Distilled water	10 oz.	500 ccs.

also heated to 110°. Digest at this temperature for one hour. If a more rapid paper is required, then after digestion cool the emulsion down to 95° F. (35° C.) and add—

Liquor ammoniæ	96 mins.	10 ccs.
Distilled water	1 oz.	50 ,,

then set and allow to stand for twenty-four hours.

For enlarging, when a much more rapid paper is required, a slow negative emulsion, such as given below, may be used. For coating bromide paper the proportion of gelatine should not be too high, although this depends upon the surface required and the method of coating, about 1 : 18 or 20 being generally sufficient. For matt emulsions, rice starch may be added as already advised for gelatino-chloride paper. For lantern plates a little more gelatine is required, say about 1 : 14.

NEGATIVE EMULSIONS

The manufacture of negative emulsions is by no means such an easy matter as positive emulsion making, but with care slow emulsions of very satisfactory quality can be produced. The beginner is not advised to attempt very rapid emulsions, as they are extremely difficult. There are two principal methods for negative emulsion making—the acid or boiling process, and the ammonia method. The former will give, as a rule, the cleaner plate, but it is not possible to obtain so high a speed. With care equally clean plates may be obtained by the ammonia method and greater speed. The acid process will be treated first.

Slow Emulsion

Potassium bromide	720 grs.	75 g.
Potassium iodide	15 ,,	2·75 ,,
Nelson's No. 1 gelatine	317 ,,	33 ,,
Hydrochloric acid	10 ,,	1 cc.
Distilled water	11 oz.	550 ccs.

Heat to 120° F. (nearly 49° C.), and add slowly with constant stirring—

Silver nitrate	960 grs.	100 g.
Distilled water	11 oz.	550 ccs.

also heated to 120° F. Digest in a water bath at boiling point for half an hour, and then add—

Hard gelatine	1,200 grs.	125 g.

which should have been well washed in water, soaked for half an hour, and drained for half an hour. Cool the emulsion, and set. This should give an emulsion of about 25 H. and D.

An emulsion of about double the rapidity, and giving somewhat greater contrast can be obtained by cooling the above emulsion down to 95° F. (35° C.) and adding—

Liquor ammoniæ (·880)	72 mins.	7·5 ccs.
Distilled water	1 oz.	50 ,,

and stirring well for about fifteen minutes, then setting and allowing to stand for twenty-four hours.

Rapid Emulsion

Potassium bromide	1,200 grs.	125 g.
Potassium iodide	24 ,,	2·5 ,,
Hard gelatine	480 ,,	50 ,,
Distilled water	10 oz.	500 ccs.

Heat to 140° F. (60° C.) and add in a fine stream with constant stirring—

Silver nitrate	960 grs.	100 g.
Distilled water	7 oz.	350 ccs.

also heated to 140° F. Digest in a water bath at boiling point for forty-five minutes, and then add—

Hard gelatine	480 grs.	50 g.
Distilled water	8 oz.	400 ccs.

The gelatine should be well washed in two or three changes of water, drained, and then dissolved in the distilled water at 110° F. (43·3° C.). This should give plates of from 150 to 180 H. and D., which are rather soft working but clean. Greater contrasts can be obtained by adding ammonia as suggested for the slow emulsion.

Slow Ammonia Emulsion

Ammonium bromide	816 grs.	85 g.
Potassium iodide	29 ,,	3 ,,
Hard gelatine	1,392 ,,	145 ,,
Distilled water	20 oz.	1,000 ccs.

Heat to 110° F. (43·3° C.), and add, with constant stirring—

Silver nitrate	960 grs.	100 g.
Liquor ammoniæ (·880)	q.s.	q.s.
Distilled water	6 oz.	300 ccs.

at a temperature of about 70° F. (21° C.). The silver should be thoroughly dissolved and enough ammonia added to redissolve the precipitate first formed. The exact quantity will, of course, depend upon the strength of the ammonia, but about 65 or 70 ccs. can be added at first, and then further additions made very cautiously, stirring well, till quite a clear solution is formed. The temperature rises to about 90° F. (32·2° C.), so that it is advisable to cool this silver solution down by standing the vessel in cold water for a short time. As soon as the emulsion is mixed, the vessel should be placed

in cold water, running water for preference, and the emulsion well stirred till quite thick and then put away in cold water to set. If allowed to stand for about sixteen hours before washing, this should give a clean working plate of about 30 to 50 H. & D., which will give great contrasts and wide latitude of exposure.

Medium Rapidity Ammonia Emulsion

Ammonium bromide .	864 grs.	90 g.
Potassium iodide .	24 ,,	2·5 ,,
Soft gelatine . .	480 ,,	50 ,,
Hard gelatine . .	480 ,,	50 ,,
Distilled water . .	20 oz.	1,000 ccs.

Heat to 120° F. (nearly 49° C.), and add, with constant stirring—

Silver nitrate . .	960 grs.	100 g.
Liquor ammoniæ (·880)	q.s.	q.s.
Distilled water . .	6 oz.	300 ccs.

at a temperature of 80° F. (nearly 27° C.). This solution should be made as before described. When mixed, the emulsion should be digested in a water bath at a temperature of 120° F. for half an hour, and then—

Hard gelatine . .	480 grs.	50 g.

which has been well washed but not soaked, added. Cool down gradually and allow to stand for sixteen hours before washing. This should give plates of from 100 to 120 H. & D.

Rapid Ammonia Emulsion

Ammonium bromide .	1,152 grs.	120 g.
Potassium iodide .	24 ,,	2·5 ,,
Soft gelatine . .	480 ,,	50 ,,
Hard gelatine . .	240 ,,	25 ,,
Alcohol . . .	2 oz.	100 ccs.
Distilled water .	18 ,,	900 ,,

Heat to 130° F. (54·4° C.), and add—

Silver nitrate . .	960 grs.	100 g.
Distilled water . .	6 oz.	300 ,,
Liquor ammoniæ (·880)	q.s.	q.s.

at a temperature of 75° F. (nearly 24° C.). Digest in a water bath at 120° F. (nearly 49° C.) for one hour, and then add—

Hard gelatine (well washed only) .	1,680 grs.	75 g.

Cool the emulsion and pour out into flat dishes; allow to stand for twenty hours. This should give plates of from 200 to 225 H. & D.

There are many little dodges which can be learnt only by experience and experiment, but the following hints may not be useless.

In making acid emulsions it is advisable always to run the silver into the bromised gelatine in a fine stream with continuous stirring. In the case of ammonia emulsions, it is not so important to add the silver in a fine stream, but vigorous stirring should be continued all the time.

If regularity of results is required it is important that the water bath should always be kept at a constant temperature, and, further, that the emulsion should be stirred about every five minutes, otherwise the silver bromide may settle to the bottom of the vessel and give coarse-grained thin-working plates that are absolutely useless. It will be noted that distilled water is advised in all the formulæ given in this article; this is important, as too often ordinary tap-water is contaminated with iron and other impurities, which lead to fog or loss of sensitiveness. It is advisable even to use distilled water for washing the gelatine.

Greater rapidity can always be obtained by reducing the quantity of gelatine during the mixing, but there is great danger of the formation of coarse grain and fog. If the gelatine is much reduced it is always advisable to add about 10 per cent. of the total bulk of alcohol, which not only prevents this but also obviates the occurrence of dichroic fog with the ammonia method.

Directions have already been given for setting and washing emulsions. When the emulsion has been washed enough it should be removed from the water and left to drain for about an hour, so as to free it from the adherent water as much as possible. In fact, it is as well to use a clean dry linen cloth, and after the emulsion has drained, place it in this and, collecting the whole into the form of a bag, squeeze thoroughly. The emulsion is then ready for melting and coating.

A test plate should always be coated first. Melt the emulsion in a water bath at 120° F. (nearly 49° C.), then take out a little and cool down to 95° F. (35° C.); coat a plate and put away to dry. The bulk of the emulsion can now be rapidly cooled down again and, when set, alcohol containing 0·1 per cent. of carbolic acid poured over the top to the depth of about half an inch, the emulsion being then put away in a dark, cool place. If it is to be used soon the alcohol may be omitted, but this will keep a stock of emulsion in good condition for a week or so.

ENAMEL, CERAMIC (*See* "Ceramic Process.")

ENAMEL COLLODION (*See* "Collodion, Enamel.")

ENAMEL SURFACES

Highly glazed surfaces. Printing papers having such surfaces are now obtainable, but formerly the worker had to produce the glaze himself. Enamel surface papers need careful washing, otherwise — especially in the case of collodion paper—they are liable to crack; they also need mounting with a quick-drying mountant, or else the moisture is liable to spoil the glaze. Methods of enamelling prints which in their normal state have ordinary or matt surfaces, will be found under the heading "Enamelling Prints." Proper photographic enamels—that is, burnt-in photographs upon porcelain, etc.—are known as "ceramics." (*See* "Ceramic Process.")

ENAMELINE, OR ENAMEL PROCESS (Fr., *Procédé émail;* Ger., *Emailverfahrung*)

A process originating in the United States, by which a copper or zinc plate is coated with a solution of fish-glue and ammonium bichromate, exposed to light under a half-tone negative, developed so as to clear away all the soluble glue between the dots, and after being dried is "burnt-in"—that is, the plate is held over a gas flame until the image turns to a deep chocolate-brown, almost black. When cool, the

plate can be etched, the enamel image resisting the etching solution. Gum is sometimes used instead of fish-glue. A suitable formula for the fish-glue solution is :—

Glue	5 oz.	500 g.
Water	10 ,,	1,000 ccs.
Ammonium bichromate	¼ ,,	25 g.

Add liquor ammoniæ (·880) until a golden yellow colour is reached.

Some workers prefer a formula containing albumen, and the following will serve :—

Le Page's fish-glue .	3 oz.	375 g.
Water . . .	8 ,,	1,000 ccs.
Ammonium bichromate	180 grs.	47 g.
Whites of 2 eggs		

Beat the egg whites, add to the glue solution, beat up again, allow to stand for eight hours and then filter through absorbent cotton.

ENAMELLING PRINTS (Fr., *Émaillure ;* Ger., *Emailleiren*)

The process of enamelling prints must not be confused with burnishing, and other methods of glazing. Enamelling proper with collodion gives the highest possible gloss. The method described below is suitable for all kinds of prints, but particularly for collodion prints : Procure some commercial collodion specially made for enamelling, or make according to the instructions given under " Collodion, Enamel," Thoroughly clean a glass plate, rub it over with a little warm wax or vaseline, polish well with a soft cloth, apply a thick coating of the enamel collodion, and allow to set thoroughly. Coat the glass evenly and out of the way of dust. This coating is to be transferred to the face of the print. By the aid of gentle heat, make a solution of gelatine in water (20 grs. to 1 oz.), and slip the collodionised glass plate film upwards into the warm, not hot, gelatine solution ; immerse a dried print also in the gelatine solution face downwards, allow it to soak, bring glass and print into contact, film to film, lift out and squeegee thoroughly until no air-bells are left, and then set up to dry. When quite dry cut round the edges of the print (through the collodion) with a sharp penknife, lift by one corner, and strip from the glass. If properly done, the print will come away easily, bringing the collodion surface with it.

As the collodion (enamel) surface is easily dulled if not mounted with a quick-drying mountant, it is the practice of some workers to back the print before or during enamelling with waterproof paper or thin Bristol board, so as to permit the use of any mountant. A good method is to soak the unmounted print in gelatine, squeegee upon the collodion plate, and then immediately after, while the print is wet, to squeegee waterproof paper or thin Bristol board on to the back of the print, using gelatine as the adhesive. When the print and mount are dry they can be stripped from the glass like an unmounted print, and then be trimmed and mounted.

ENAMELOID (Fr., *Énameloid ;* Ger., *Enameloid*)

A dead-black varnish suitable for the inside of lens mounts, diaphragms, etc., said to consist of celluloid dissolved in acetone, with the addition of vegetable black.

ENCAUSTIC PASTE (Fr., *Colle encaustique ;* Ger., *Enkaustische Kleister*)

Known also as cerate paste ; a mixture for rubbing on to the surface of prints in order to give them a gloss, deepen the shadows, and brighten them up generally. The gloss obtainable is very pleasing, but not so high as that obtained by burnishing or enamelling. It is particularly suitable for matt bromide and platinotype prints, and at one time was widely used for prints on albumen paper. In its simplest form it consists of 1 part (by weight) of ordinary beeswax reduced to a paste with four parts of turpentine, the smell of which can be masked by substituting 1 part of oil of lavender for 1 part of turpentine. The wax is soaked in the solvent and then melted gently by heat. Another simple paste is that made according to Dr. Eder's formula :—

White wax . .	1 oz.	500 ccs.
Dammar varnish .	200 mins.	209 ,,
Oil of turpentine .	1 oz.	500 ,,

Dissolve by heat and mix well. A more elaborate mixture, and one widely used, is that made according to the Adam Salomon formula :—

Pure virgin wax .	500 grs.	500 g.
Gum elemi . .	10 ,,	10 ,,
Benzole . . .	½ oz.	240 ccs.
Oil of lavender . .	¾ ,,	360 ,,
Oil of spike . .	1 drm.	60 ,,

Melt in a hot-water bath, mix thoroughly, and strain through muslin ; or the gum may be dissolved in the solvents and the melted wax added after filtration. A small quantity of any of the above mixtures is applied to the print by means of a small piece of flannel or linen, and is then worked into the print by continuous rubbing, a polish being obtained finally by rubbing with a clean piece of flannel or a pad of clean linen.

The following mixture was at one time largely used for painting with a brush over the shadows of a print in order to deepen them ; it is not encaustic paste proper, but can be used when it is not desired to cover the whole of the print :—

Gum arabic . .	½ oz.	16·5 g.
Water . . .	3 ,,	100 ccs.
Rock candy . .	1 drm.	4 ,,
Acetic acid . .	10 drops	·7 ,,
Alcohol . . .	10 ,,	·7 ,,

ENDEMANN'S PROCESS (Fr., *Procédé Endemann ;* Ger., *Endemann's Prozess*)

An aniline printing process, giving a black image on a white ground. The paper is sized with a solution of 1 oz. of sheet gelatine in 50 oz. of water, and sensitised with :—

A. Sodium chloride (common salt) .	480 grs.	846 g.
Potass. bichromate .	480 ,,	846 ,,
Sodium vanadiate .	320 ,,	564 ,,
Water . . .	20 oz.	1,000 ccs.
B. Sulphuric acid .	2 oz.	100 ccs.
Water . . .	10 ,,	500 ,,

The acid must be introduced gradually into the water, and the mixture, when cold, added to A.

The paper is floated on the surface of the sensitiser, and hung up to dry in the dark. It is exposed under a negative or tracing in a printing frame for about seven minutes, and development is carried out by exposing the print to the vapour arising from a heated mixture consisting of ½ oz. of aniline to 25 oz. of water (22 g. in 1,000 ccs.) for about one minute, which produces a brown image. The print is then placed in a room filled with steam for about two hours, or until the image turns black. To remove the green colour that usually remains, wash carefully in a solution of liquor ammoniæ (·880) 2 oz., to water 12 oz. (166 ccs. liquor ammoniæ to 1,000 ccs. water).

ENERGIATYPE

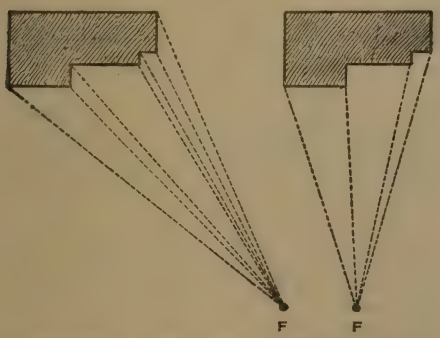
A process (now obsolete) invented and named by Robert Hunt about 1851. It has been called a ferrotype process, but ferrotypes are now understood to be pictures upon a blackened tin surface. Good writing paper was prepared by washing over with :—

Succinic acid . .	5 grs.	2·5 g.
Common salt . .	5 „	2·5 „
Gum arabic solution	½ drm.	30 ccs.
Water . . .	1 oz.	500 „

When dry, the paper was sensitised on a solution of silver nitrate 60 grs., water 1 oz., and dried in the dark. The paper was used in the camera as a plate, an exposure of about 30 seconds being enough for a brightly lighted landscape, and six times as long for a portrait. The image remained invisible until developed, the developer being made in the proportion of 1 dram of a saturated solution of iron protosulphate and 3 drams of gum arabic solution. The picture was then fixed with ammonia and finally well washed.

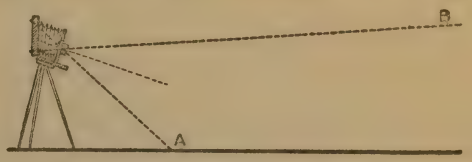
ENGINEERING PHOTOGRAPHY

Most of the technical considerations that apply to architectural photography apply equally well to engineering subjects. The truth of vertical lines must always be preserved by keeping the



A. Diagrams showing the Influence of Viewpoint in Engineering Photography

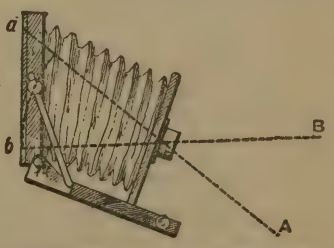
sensitive plate vertical, whether the view of the machinery necessitates looking upwards or downwards. In many cases abnormal points of view have to be taken, and the camera may have to be raised several feet in order to show essential features that cannot be seen from any other position. One of the most important considerations in engineering photography must always be to show the essential features of the work in an effective manner. Technical knowledge, or even a slight acquaintance with engineering practice, will be exceedingly valuable to the photographer who undertakes work of this



B. Camera Tilted Downwards

character. The object of the photograph is to illustrate the working of the machine; to show most plainly its principal working parts and the manner in which its object is attained. Subject to these considerations, an oblique view should always be taken, if possible, in preference to a full front or side view. By choosing a position that gives a good perspective, the relief and projection of the various parts are shown, as well as their solidity and their relation to each other. In a view taken from the front, the sense of relief is largely lost; the machine appears flat, its functions are not well shown, and its working is much more difficult to follow. The diagrams at A show plainly the reasons for this; they represent a plan of a machine with the camera F placed in different positions. Sharp definition throughout is essential. Whenever possible, machines should be painted a good medium grey or lead colour, this assisting in rendering detail effectively throughout, and particularly in the shadows and light parts. The colour should be quite dull, a glossy surface being very undesirable. Bright parts may generally be left untouched, as they then look more natural than if painted white, as sometimes advocated. Paint gives an effect suggesting wood.

In many subjects difficulties in working may present themselves, and require ingenuity combined with photographic skill to overcome. In



C. Method of Using Swing-back

photographing a subject with a long range of distances, the following method has been very efficient. The subject was some electrically controlled railway points, and it was very necessary to show the mechanism between the rails as large as possible. The camera was placed about eight or ten feet from the principal part of the subject, but signals and other objects five or six

hundred feet away were included, and all had to be sharply defined. The distance was entirely at the top of the picture, and the foreground at the bottom, the camera being placed as in diagram B. By tilting the camera downwards and using the swing-back, as shown at C, sharpness was obtained throughout by using a medium aperture, as the foreground A in the diagram was focused at *a* in the camera, and the distance B at *b*. Previously it was found that with the back and front of the camera parallel, *f*/64 failed to render the different planes reasonably sharp.

In all engineering subjects wide-angle lenses should be avoided as much as possible. In photographing complete workshops or very large pieces of machinery, they may be absolutely necessary, but for single machines of small or moderate size, a medium-angle or a long-focus lens should always be used.

In many cases machines can be photographed out of doors, and this is frequently preferable to the lighting in many workshops.

In most cases, engineers wish to have a clear white background for all isolated pieces of machinery; this necessitates painting out the background on the plate (*see* "Blocking Out, or Stopping Out"), unless the work may be left to the process-worker's retoucher.

Photographing workshops is treated in the article "Factories, Photographing in," and notes on the exposures for these subjects are given under the heading "Exposure Tables."

ENGRAVED BLOCKS

A term correctly applied to wood-engravings, but now commonly used to denote all kinds of blocks, whether engraved by hand or produced photo-mechanically.

ENGRAVING (*See* "Half-tone Process," "Photo-engraving," etc.)

ENGRAVING ON GLASS

Photographic processes have been employed to produce an image on glass as a resist for etching by means of hydrofluoric acid. The bitumen process is one of the best for the purpose of forming the resist image.

ENGRAVINGS, COPYING

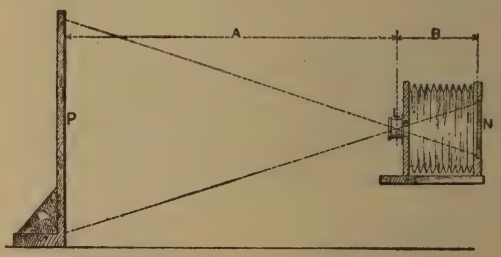
In copying engravings and drawings the only difference in working arises from the fact that the subject consists of black lines on a white ground, a type of subject that is usually considered difficult on a gelatine plate, as it is far from easy to obtain sufficient contrast with ordinary plates. By adopting the following method of working little difficulty should be experienced in obtaining a negative that will give all the contrast required in the print. A slow plate of the kind specially prepared for this work should be chosen, and it should be backed. A fine-grain ordinary, or a process plate, will answer well. Correct exposure is very important. The following method of timing will ensure correct exposure. Place the exposure meter flat against the drawing to be copied, and note the time required to match the standard tint. Using *f*/16 and a plate of the speed of 40 H. and D., one half of the time that a Wynne meter requires, or one fourth of the time required by a Watkins meter to reach the tint, will be the correct exposure for copying the same size as the original. For other plates or for different scales, the proportionate exposures can easily be found from these data. Should the lines show distinct signs of veiling, development should be stopped, and the negative afterwards intensified, if necessary. (*See also* "Copying," etc.)

In process work, an engraving on thin, clean paper, and with good black lines, without printing on the back, may be copied by using it as a diapositive. It is placed in contact with a sensitised zinc plate and exposed to light for a sufficient time. A negative image will be developed, but this may be converted into a positive one by flowing with a shellac varnish containing some colouring matter to make it visible. The latter will attach itself to the bare zinc lines, whilst that which rests on the sensitive colloid film will be dissolved away by treating the plate in a bath of weak acid.

Playertype (*which see*) is also an easy process for copying engravings on to sensitive paper.

ENLARGING

The operation of enlarging consists simply in taking a print from a negative by means of a lens instead of by placing a paper in contact with the surface of the negative in the usual manner. The essential parts of the apparatus required are a holder for the negative from which the enlargement is being made; a camera body or similar arrangement of which the negative holder forms one end, a lens being fitted at the other; and a board or easel for holding the paper on which the enlargement is being



Principle of Enlarging

made. The positions of the easel and the lens should both be adjustable, so that enlargements of any desired size may be made. The illustration explains the arrangement fully. N is the negative, L the lens, and P the paper. The type of lens used for making an enlargement is not important, beyond the fact that it ought to cover the plate with crisp definition from corner to corner with a fairly large aperture. If it is necessary to use a small stop to obtain good definition, the exposures required may be inconveniently long. Also, a lens of long focus should be avoided, especially if very large pictures are desired from small plates, as the apparatus would have to be very long. If the focus of the lens is known, the apparatus may be set up approximately in position for any degree of enlargement by measurement, leaving only the fine focusing; it will then be easy to

ascertain what degree of enlargement forms the limit of the apparatus.

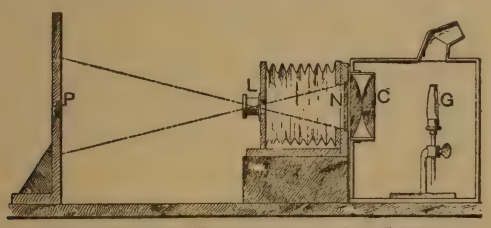
The distance A from the centre of the lens to the sensitive paper must be equal to the focus of the lens multiplied by the degree of enlargement, with the focus of the lens added to the result. The distance B from the centre of the lens to the negative must be the distance A divided by the degree of enlargement. The distance A bears the same proportion to B as the enlargement bears to the original negative. An example will render this clear. A lens of 6 in. focus is being used to enlarge a 4 in. by 3 in. picture up to 12 in. by 9 in. The degree of enlargement is three times linear. Three times 6 in. is 18 in., plus 6 in. brings the distance A up to 24 in.; and this distance divided by 3, the degree of enlargement, gives 8 in. as the distance B. These general principles apply equally to all methods of enlarging. Details of making enlargements on paper direct, or by means of enlarged negatives, are given in later articles.

It is useful to know the relative exposures for different degrees of enlargement, when all the conditions are equal. Beginning with the production of a print the same size as the original as a basis, and calling the exposure for this 1, the relative exposures for other degrees of enlargement, using the same stop throughout, will be :—

Degree of Enlargement	*Exposure*
1	1
1½	1½
2	2¼
2½	3
3	4
4	6¼
5	9
6	12

ENLARGING BY ARTIFICIAL LIGHT

The principal difference between enlarging by daylight and by artificial light consists in the method of illuminating the negative evenly and



Enlarging by Incandescent Gas Light

with sufficient strength to obtain an enlargement in a reasonable time. A necessary element is a condensing lens for collecting the light and presenting it in the form of an evenly and brilliantly illuminated disc immediately behind the negative from which the enlargement is being made. The source of light may be an oil lamp, a gas flame, or an electric lamp. The first-named is the least satisfactory by reason of its variable character and comparatively poor quality. An incandescent gas burner is one of the most satisfactory for general use. At times the light is projected in the form of an enlarged image of the mantle, and a similar difficulty may arise with an incandescent electric lamp. This may be entirely obviated by interposing a sheet of ground glass between the light and the condenser, as near the latter as possible. Other methods of lighting the negative are sometimes adopted, but in practice they are far from satisfactory. The diameter of the condensing lens must be fully equal to the diagonal of the plate that is being used—for example, 5¼ in. or 5½ in. for a quarter-plate; but there is no advantage in any size in excess of this. The usual arrangement is to enclose the light in an iron casing, one end of which holds the condenser. By this method the light is excluded from the room, so that the paper can be handled freely, and the enlargements developed without any risk of fogging, excepting when an exposure is being made. As close to the condenser as possible there is a carrier for holding the negative; this carrier forms the back of a camera body, the opposite end holding the lens for projecting the image. Beyond the lens an easel or board is required for holding the sensitive paper, and, as the distance between this board and the lens, and between the lens and the negative, must be varied according to the degree of enlargement, a method of extending the camera body, and one for sliding the easel, have to be provided. The easel should slide on guides, as it is imperative that it should be quite parallel with the negative. The arrangement will be more easily understood from the illustration, in which G is an incandescent gaslight, C the condenser, N the negative, L the lens, and P the paper on which the image is received.

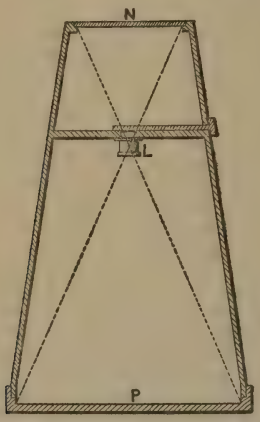
The exposure will depend on the negative, the paper, and the degree of enlargement. In enlarging from quarter to whole-plate by incandescent gas, with lens aperture *f*/8, the exposure will vary from ten seconds for a thin negative up to forty for a strong one, using a commercial bromide paper. A test exposure on a small piece of paper should always be made before making the enlarged print. The test piece should include the strongest part of the negative.

Any negative that will give a good contact print on bromide paper will yield a good enlargement by incandescent gaslight with a condensing lens for concentrating the light.

ENLARGING BY DAYLIGHT

This method gives greater opportunity for varied methods of working to suit the conditions of different photographers than does enlarging by artificial light. The apparatus and the manner of using it may range from the simple and inexpensive fixed-focus enlarger up to a permanently arranged apparatus in which the darkroom itself forms the camera in which the enlargement is made. The general principle is illustrated in the article "Enlarging." It is the method of adapting that principle to the requirements of the worker that varies. The most simple is the fixed-focus enlarger, a piece of apparatus in the form of a double box, which allows one degree of enlargement only. This is an inherent disadvantage of a fixed-focus instrument, but it has the advantage of great convenience; it is ready for use at a moment's

notice, without any focusing or arranging. The negative is placed film downwards at N (*see* illustration A), the paper put in position at P; the apparatus taken out of doors, so that the light from the sky overhead falls directly on

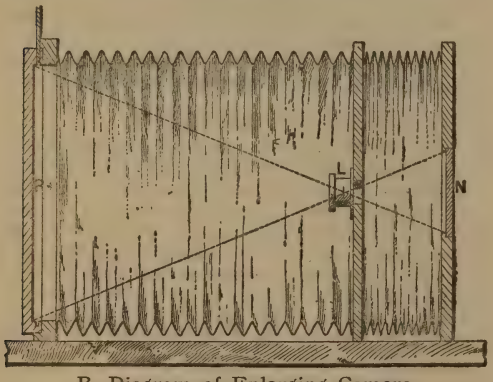


A. Diagram of Fixed-focus Daylight Enlarger

the negative, and the exposure made by operating the shutter that closes the lens L. This apparatus gives enlargements of one uniform size only, this size varying with its construction and the size of the negatives for which it is intended.

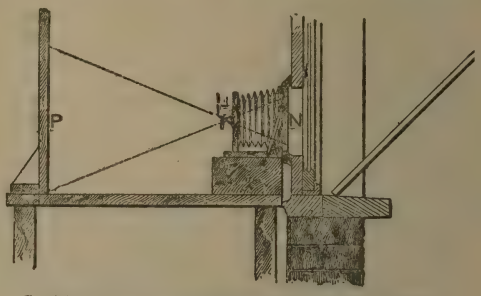
A second form of apparatus is an enlarging camera (*which see*). Illustration B shows how the apparatus is used: N is the negative, L the lens, and P the sensitive paper.

A third arrangement is one that is frequently adopted by those who do much enlarging, and who wish to have a much larger range in size than that which can be obtained in an enlarging camera. The dark-room, or a room that can be darkened by closing the window with a specially-made shutter, becomes the enlarging camera. The camera in which the original negative was taken, and an enlarging easel, are



B. Diagram of Enlarging Camera

practically all the apparatus that is required. The window of the room is closed by a shutter (*see* illustration C), in which is a small opening a little larger than the negative. Outside the shutter a reflector of white card or a dull white painted board is fixed so as to reflect the light from the sky through the negative. Inside the room the camera is supported on a table opposite the opening in the shutter. The negative N is placed in the camera back, film



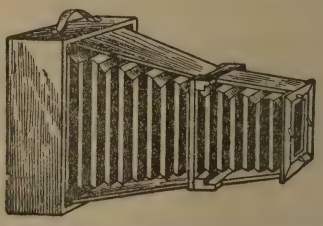
C. Showing use of Reflector in Daylight Enlarging

towards the lens, and a focusing cloth wrapped round the camera back so as to prevent any light leaking into the room. On the table an easel holding the paper P is arranged to slide in guides, the image being projected by the lens L in the usual manner.

A difficulty in daylight enlarging is the ever varying character of the light. A test should always be made by a meter immediately before making an exposure. It is only by this method, and small test pieces as described in "Enlarging by Artificial Light," that correct exposures can be secured. Any negative that will give a good contact print on bromide paper will yield an equally satisfactory enlargement by daylight.

ENLARGING CAMERA (Fr., *Chambre d'agrandissement*; Ger., *Vergrösserungskamera*)

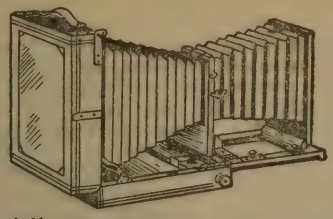
A camera for making enlarged photographs on bromide paper, or enlarged negatives, from smaller negatives or positives. It consists essentially of a carrier or holder for the negative, a dark-slide or frame for the bromide paper, and, between these, a support for the lens, the whole being covered in except the end at which the negative is placed. In a fixed-focus enlarging camera, of which A is a typical example, the distance between negative, lens, and dark-slide cannot be varied, and only one size of enlargement is possible; but in other forms of appara-



A. Fixed-focus Enlarging Camera

tus, as in B, there is provision for altering these distances to obtain enlargements of different sizes. The cameras just considered do not require the room to be darkened if used indoors; they may, if preferred, be used outdoors. The

non-portable enlarging camera, however, as generally used in trade establishments, is placed close against a window, from which all actinic light except that illuminating the negative is blocked out. With this form of enlarger an



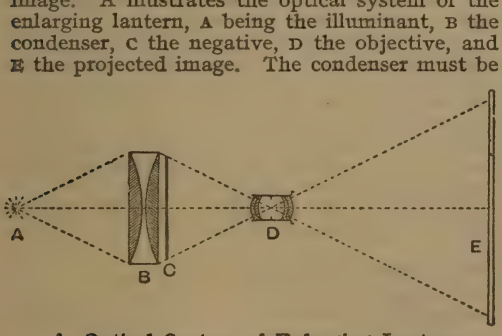
B. Adjustable-focus Enlarging Camera

easel is usually employed instead of a dark-slide. Any ordinary camera may be used in this way if a suitable holder or carrier is made for the negative; or the negative may be placed in the dark-slide, this being inserted in the camera with both shutters drawn, to serve as a carrier. To obtain a uniform light, a white card or reflector is fixed outside the window at an angle of 45°. An alternative is to use a sheet of ground glass, or to paste white tissue paper over the opening which admits light; when this is done the negative should be a few inches distant from the opening instead of close against it. Various lamps are obtainable to fit behind the negative carrier of daylight enlargers, thus enabling them to be used by artificial light.

ENLARGING EASEL (*See* "Easel, Enlarging.")

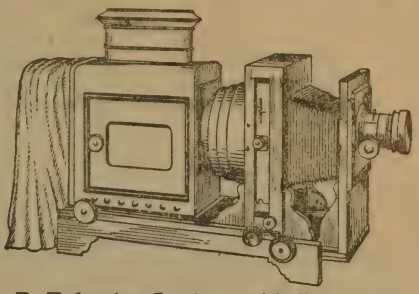
ENLARGING LANTERN (Fr., *Lanterne d'agrandissement*; Ger., *Vergrösserungs-apparat*)

A lantern used in enlarging by artificial light, to project a magnified image of the negative on the bromide paper. It consists of a body carrying the illuminant, a condenser to concentrate the light on the negative and cause it to pass out from the latter in a converging cone, and a projecting lens or objective to receive the cone of light from the condenser and to form the enlarged image. A illustrates the optical system of the enlarging lantern, A being the illuminant, B the condenser, C the negative, D the objective, and E the projected image. The condenser must be



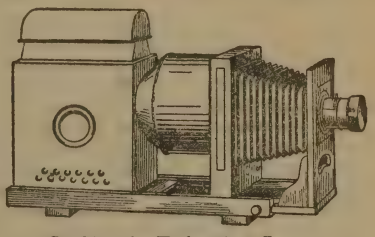
A. Optical System of Enlarging Lantern

of sufficient size to illuminate the whole of the negative, or part of the image will be cut off towards the margins of the enlargement; on the other hand, there is no advantage in having too large a condenser, but rather the reverse, as light is wasted. For a quarter-plate negative, a $5\frac{1}{2}$-in. diameter condenser is required; for a half-plate, one of $8\frac{1}{2}$ in. diameter; and for a whole-plate, one of 11 in. diameter. The condenser has nothing whatever to do with the size



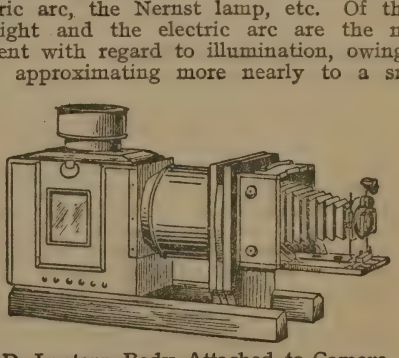
B. Enlarging Lantern with Rack and Pinion Adjustments

of the enlargement; this depends, other things being equal, entirely on the distance of the bromide paper from the projecting lens or objective. The objective should be capable of covering the size of negative to be enlarged, and of sufficient diameter and aperture to pass the whole of the beam of light proceeding from the condenser. The lens used in making the nega-



C. Simple Enlarging Lantern

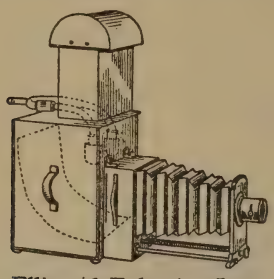
tive is usually suitable for enlarging, the best possible projection lens being probably a good anastigmat. There are numerous illuminants employed for enlarging, as oil, acetylene, incandescent gas, incandescent spirit, limelight, the electric arc, the Nernst lamp, etc. Of these, limelight and the electric arc are the most efficient with regard to illumination, owing to their approximating more nearly to a small



D. Lantern Body Attached to Camera

point of light; but from the point of view of general convenience and utility, incandescent gas is perhaps the favourite. The proper adjustment of the illuminant is of importance, or the enlargement will be unevenly lit. The

correct procedure is to place the negative in the carrier and to focus roughly to the required size, approximately centring the light and bringing it to that distance from the condenser which seems to give the best and most even illumination. The negative is then removed, and the illuminant moved back till a dark ring appears round the disc of light on the easel. The illuminant is now carefully centred till the ring is equal all round, and is then pushed toward the condenser



E. Ellipsoid Enlarging Lantern

till the ring disappears and a perfectly even lighting is secured, the negative being finally re-inserted and sharply focused. Any after alteration in the size of the enlargement will require a fresh adjustment of the illuminant.

B shows a typical high-class enlarging lantern which has rack and pinion adjustments throughout, including provision for moving the lantern body, the condenser, and the objective. The negative carrier is furnished with rising, falling, and swing movements, and a rise or fall is also permissible with the lens. C illustrates a cheaper enlarging lantern, of simple yet efficient construction; while D represents a useful type dispensing with the extension bellows and projection lens, and intended to take an ordinary camera in front. In another form of enlarging lantern, known as the ellipsoid enlarger, no condenser is used, the negative being lit by reflected light from a curved opal reflector; these enlargers are made either for use with the worker's own camera, or with a bellows and projection lens, as in E, where a pair of inverted incandescent gas burners form the illuminant.

ENLARGING NEGATIVES

In order to make a large negative from a small one, two operations are necessary. A transparent positive must be made from the original negative, and from that a new negative can be made by enlarging to any desired size. The character of the transparent positive is of the greatest importance in determining the character and quality of the new negative. The extreme shadows or densest parts should be moderately strong, but such an exposure should be given that the highest light is veiled. No part should be quite clear, and the transparency should be dull rather than brilliant. The best method for making the transparency is by contact printing by artificial light on a rapid plate, thus securing the truest reproduction of the gradation of the original. For the same reason—the desirability of reproducing all the gradations as correctly as possible—the enlarged negative should partake of the same character; the deepest shadow should be veiled, otherwise there will be a distinct loss of tone values. The method of working is given under "Enlarging by Daylight" and "Enlarging by Artificial Light," excepting that the transparent positive is placed in the position there described for the negative and a plate in the position given for the sensitive paper. Backed plates should be used for making the transparency and the enlarged negative, and the film side should be towards the lens in each case. Film towards film is the rule, as in printing. An exception to this is when a reversed negative is required for the carbon process. In that case the transparent positive is reversed in the carrier, the glass side being turned towards the lens.

Enlarged Paper Negatives.—Enlarged negatives may be made on bromide paper from lantern slides or other transparencies, the bromide paper after exposure being treated with a weak bichromate solution, as described under the heading "Sterry's Process," in order to obviate harsh results. By the W. Coats method, an enlargement is made on rapid smooth bromide paper, the exposure being short so as to keep the shadows clear; amidol is used as the developer and the print is washed for two minutes; the unfixed print is then toned in the following bath, in which it should remain for seven minutes, at least:—

A.	Pot. ferricyanide	40 grs.	8 g.
	Glacial acetic acid	½ oz.	50 ccs
	Water	10 ,,	1,000 ,,
B.	Uranium nitrate	40 grs.	8 g.
	Glacial acetic acid	½ oz.	50 ccs.
	Water	10 ,,	1,000 ,,

Take equal parts of each just before use. The solutions keep well separate, but not when mixed. When toning is complete, the print is well washed and immersed for one minute in a solution of 20 grs. (4 g.) of ammonium sulphocyanide in 20 oz. (1,000 ccs.) of water. The print is washed again for two minutes and then exposed to 4½ in. of magnesium ribbon burning at a distance of 12 in. from it. The print is next rinsed and redeveloped in the original amidol developer, fixed in "hypo," and washed. A metol-hydroquinone developer has been suggested in place of the amidol.

An important point which must not be overlooked in all enlarging processes is the increase in contrast in the resultant print or plate. This is caused by the scattering of the light by the silver grains of the negative, which practically act as points from which the light spreads or scatters out in fan-shaped bundles, and therefore does not reach the lens. This may be overcome by placing the negative film side next to a sheet of fine matt opal glass.

ENLARGING ON PAPER

The most simple and satisfactory method of enlarging is to produce an enlarged print on paper direct from the original negative. It is not only the most simple method, but it ensures the truest reproduction of the gradation and quality of the negative. There is only one printing medium sufficiently rapid for direct enlarging—at least, by artificial light—and that is paper coated with a silver bromide emulsion. (*See* "Bromide Paper.") Enlarged prints pro-

duced on this paper are in every respect equal to contact prints from the same negative, and the development, fixing, and after processes are precisely similar. The only difference is in the methods of obtaining the print. These are given under "Enlarging by Artificial Light" and "Enlarging by Daylight."

ENLARGING BY STRIPPING

A process of stripping a film from an ordinary unvarnished negative, enlarging it, and attaching it to a larger glass; the process dates from 1882. The following enlarging mixture is required:—

Hydrofluoric acid	1 drm.	31 ccs.
Citric acid	½ oz.	125 ,,
Glycerine	1 drm.	31 ,,
Acetic acid	½ oz.	125 ,,
Water	4 ,,	1,000 ,,

The hydrofluoric acid needs careful handling. The negative is placed in the solution and the film will gradually become released from the glass and at the same time be enlarged. If necessary, the film can be assisted to leave the glass by means of a camel-hair brush. It is next carefully rinsed in water and floated upon, and squeegeed into contact with, a cleaned glass of the required size. In this way a quarter plate may be expanded to fill a half plate, and larger sizes in proportion. When in contact with the new and larger glass it must be allowed to dry naturally. As may be expected, films enlarged in this manner give slightly thinner results, and a rather dense original is therefore advisable. Films may be stripped from negatives without any enlargement. (*See* under the heading, "Film Stripping.") The older the negative the more difficult it is to strip and enlarge.

ENSEMBLE (Fr.)

The arranging or grouping of several figures or of the constituent parts of a picture.

ENVELOPE SYSTEM (*See* "Daylight Changing.")

EOSINE (Fr., *Eosine;* Ger., *Eosin*)

Synonym, yellowish eosin or eosine. $C_6H_4(CO\,C_6H\,Br_2\,OK)_2\,O$. Molecular weight, 708. Soluble in water, alcohol, and ether. It usually occurs as a red powder. The sensitising power of eosine lies between E and D in the green and yellow green, but does not reach the D line.

METHYLERYTHRINE is the methylic ether and primrose, or erythrine is the ethylic ether of tetrabromofluoresceïn.

The eosines are a somewhat large class of dyes known generally as the phthaleïn group, and derived from triphenylmethane. The first dye of this group is:—

FLUORESCEÏN (Fr., *Fluorescine;* Ger, *Fluorescein*)

Solubilities, insoluble in water, soluble in alcohol. A brick red powder of little photographic interest except as the starting-point of other dyes. Its sodium salt is called:—

URANIN (Fr., *Uranine;* Ger., *Uranin*)

$C_{20}H_{10}O_5Na_2$. Solubilities, soluble in water, alcohol, and ether. A brownish red powder which is sometimes used for making yellow screens or dark-room filters.

Assuming the formula for fluoresceïn to be $C_6H_4(CO\,C_6H_3\,OH)_2\,O$, the hydrogen atoms of the resorcinol group in brackets can be replaced by the halogens chlorine Cl, bromine Br, and iodine I., and according to the number of substitutions there are formed monobromofluoresceïn, dibromofluoresceïn, known as eosine extra yellow, and tetrabromofluoresceïn yellowish eosin; these are used for sensitising collodion emulsion for yellow-green; and the monobromofluoresceïn is an excellent green sensitiser. Their action on gelatine plates is less satisfactory than that of erythrosine. All these dyes have a greenish fluorescence in solution, and form salts when mixed with silver nitrate which are practically insoluble in water.

In process work, eosine is often used for dyeing the fish-glue image in the enameline process; but methyl violet is more commonly employed, and is preferred because it shows up the image in greater contrast.

EPHEMERAL PHOTOGRAPH

A kind of phosphorescent photograph, produced by one of the many processes introduced by the late W. B. Woodbury. Largely quoting from his own words, the process is simple, and the same piece of sensitised paper may be used over and over again, while at the same time always retaining its sensibility. The material is the phosphorescent powder, calcium sulphide, obtained by calcining oyster-shells and treating with sulphur. A sheet of paper is coated with this by covering with gum or varnish, and dusting the powder over it. If this paper is exposed for a few seconds to light under a positive transparency and then removed to a dark-room, a luminous positive will be seen, lasting a longer or shorter time, according to the exposure given. Woodbury also produced luminous portraits and views by the dusting-on process, substituting the powder named for plumbago. (*See also* "Luminous Photographs.")

EPSOM SALTS

The common name for magnesium sulphate, which has been advocated as a preventive of frilling; the dry plate previous to development is soaked in a saturated solution of the salts. Also, a saturated solution of the salts made with beer and a little gum water is used for "frosting" studio and other plain glass windows.

EQUIVALENT FOCUS (*See* "Focal Length.")

ERYTHROSINE (Fr., *Érythrosine;* Ger., *Erythrosin*)

Synonyms, erythrosin, bluish eosin, iodoeosin. $C_6H_4(COC_6HI_2\,ONa)_2\,O$. Molecular weight, 660. Soluble in water, alcohol and ether. It is a bluish red powder which, when pure, gives no fluorescence in aqueous solution, and but slight fluorescence in alcoholic. It forms an insoluble silver salt, erythrosinate, or tetraiodofluoresceinate of silver, which is used with collodion emulsion for colour sensitising. Erythrosine is the most energetic yellow-green and yellow sensitiser for gelatine emulsions, its action extending from E to beyond D; it leaves, however, a characteristic minimum or lack of sensitiveness in the blue-green between *b* and F. It may be added

to the emulsion at the time of mixing, in which case 0·2 per cent. should be added to the bromised gelatine before adding the silver nitrate, or it may be added the last thing before coating, or it may be applied in the form of a bath to the finished and dried plate; this method gives the greatest colour-sensitising effect. The plate should be soaked for two minutes in :—

Liquor ammoniæ	96 mins.	10 ccs.
Distilled water to	20 oz.	1,000 ,,

drained and immersed in—

Erythrosine	·96 grs.	1 g.
Liquor ammoniæ	192 mins.	20 ccs.
Distilled water to	20 oz.	1,000 ,,

and then well dried in the dark. A considerable saving of time is effected in the drying if one third of the quantity of water in the above formula be replaced by alcohol or acetone.

Erythrosine M is the sodium or potassium salt of tetrabromofluoresceïn as above; erythrosine G is a similar salt of diiodofluoresceïn.

ESSENCE OF JARGONELLE (*See* "Amyl Acetate.")

ETCHING (Fr., *Morsure;* Ger., *Aetzung*)

The incision of metals by means of acids or other corrosive fluids, as distinguished from engraving, which implies incision by cutting with a graver. Etching may be of two kinds: (1) The older form consists in spreading an acid-resisting coating, or "ground," on the metal plate and scratching through it by means of sharp points so as to lay bare the metal. This is the process used by artist etchers, from Rembrandt down to the present-day workers. (2) The other and more modern method, in which photographic processes play so large a part, consists in forming an image on the plate in ink, varnish, or other suitable acid-resisting medium, and then etching away the bare parts of the metal. The image may be applied by drawing direct on the plate, by transfer from a greasy ink image on paper, or by photography with a sensitive film. The last-mentioned method, now by far the most common, is called photo-etching. The methods of forming the image on the metal are treated under various headings—for example, "Albumen Process," "Fish-glue Process," "Enameline," "Bitumen," etc.—and the etching inks, solutions, metals, etc., are also separately described. Etching may be either in relief or intaglio, the former being necessary for typographic printing and the latter for copper and steel plate printing. There are two divisions—line etching, which reproduces lines, stipples, and solid patches of colour; and half-tone etching, which interprets the tones of a photograph or painting by means of a dot system. Colour etching is merely an extension of one or other of these processes.

Photogravure etching (*which see*) is different in principle. In ordinary etching the sunk lines, or spaces between the lines, are practically of uniform depth, but in photogravure etching the depth is proportionate to the tones, the shadows being sunk the deepest into the plate.

ETCHING BATHS

This term is applied to the etching solutions and also to the troughs and trays used for holding them. To prevent confusion, the vessels themselves are treated in the present article, the solutions being described separately in the article headed "Etching Solutions." The baths are of wood, lined with pitch or gutta percha; of slate; or of earthenware; and they are generally mounted on rockers, so that the solution may be washed to and fro over the plate. The ends are covered to prevent the splashing of the acid out of the trough. In large shops the troughs are mounted on a rocking machine driven by motor and worm gearing, this ensuring more uniform etching.

ETCHING INK

There are numerous formulæ for etching inks, these varying according to the particular branch or process of etching for which they are required. In America the term is limited to the ink used for rolling up the albumen bichromate print after exposure as a preliminary to development. Excellent commercial inks are obtainable, so that it does not pay to make one's own ink, but it may be useful to know that such an ink usually consists of beeswax, soap, shellac, lithographic ink, lithographic varnish, and similar ingredients well mixed together. Etching ink, as usually understood by English workers, may also mean "starting ink," or soft etching ink, and "finishing ink," or hard etching ink. These inks can also be purchased ready-prepared. The former consists of such ingredients as Russian tallow, yellow beeswax, asphaltum, lithographic or letterpress printing ink, and thin lithographic varnish. The object of this resist is to form a covering for the shoulders of the lines by running down the sides when the plate is heated. It is usually applied by inking the surface with a lithographic leather nap roller. The "finishing ink" consists of beeswax, resin, asphaltum, and lithographic printing ink. It is necessary to warm the plate in order to get the ink to "take," and it is applied by means of a lithographic glazed leather roller.

ETCHING MACHINES

Since about 1895 etching machines have come much into vogue in photo-engraving establishments. The earliest machine of the kind to be brought into commercial use is the Levy Acid Blast. (*See* "Acid Blast.") The Axel etching machine, invented by Axel Holmström, has a paddle-wheel working in the bottom of the etching trough and throwing the acid against the plate, which is placed almost vertically against the side of the trough. The Mark Smith machine is similar in principle, but the plate is placed horizontally over the etching trough, and remains stationary. The Albert etching machine consists of a horizontal trough which has a slow reciprocating motion. The plate is laid face up on a platform at the bottom of the trough. This platform is lifted out of the solution when the lid is raised. This lid has on its underside a series of ribs or vanes, and it is given a rapid reciprocating motion when laid down over the plate, so that the acid is put into a state of violent agitation, causing the plate to be etched more rapidly than it would be in a rocking trough. The "Holt" etching machine has a trough and a lifting plat-

form similar to the Albert machine, but the solution is agitated by means of a rotating disc, on the underside of which are vanes for churning up the solution. The "Danesi" machine rains the acid down on the plate from a trough above, into which the acid is pumped from the etching trough below.

Various other forms of etching machines have been proposed and patented, but the foregoing have come into regular use.

ETCHING METALS

The metals used for etching are generally zinc, copper, brass, and steel. Zinc is mostly used for line work, copper for half-tone and photogravure, brass for half-tone and for bookbinders' blocking plates, and steel for die printing. Carefully smelted and rolled metal is used, and the sheets are highly planished and polished. For line and half-tone the plates are usually from 14 to 16 B.W.G. (·083 in. to ·065 in.) in thickness, and the metal is purchased ready for use.

ETCHING SOLUTIONS

For zinc etching nitric acid is invariably used, the strength varying from 1 to 20 per cent. according to the stage of the etching and the nature of the work. The bath has to be constantly rocked whilst the plate is being etched. A "still" etching solution, which does not require rocking, consists of :—

Nitric acid . . .	130 parts
Water	100 ,,
Sal ammoniac . . .	20 ,,
Pyroligneous acid (wood vinegar)	20 ,,

The bath should stand two or three weeks after mixing. Another bath for zinc which need not be rocked is :—

Sulphuric acid	6 parts
Potassium nitrate . . .	2 ,,
Water	20 ,,

Dissolve the potassium nitrate in water, and then gradually add the acid. Dilute with water till bubbling ceases.

For etching an enamel film without "burning-in" the image, the following bath is recommended :—

Alcohol (40 %) . .	400 parts
Nitric acid . . .	5 to 7 ,,

For half-tone copper etching, iron perchloride is dissolved in water until the solution registers from 35° to 40° on the Beaumé hydrometer (up to 1·36 sp. gr.). About 1½ lb. perchloride to 1 pint of water will bring the solution to the required strength. The solution is improved for immediate use by adding ½ pint of an old bath to every quart of new. Rocking the bath makes the etching proceed more quickly. Heat also aids the etching. Sometimes the plate is etched face downwards, held in a clamp.

Brass is also etched with perchloride of iron at 35° Beaumé.

Steel can be etched with ferric perchloride at 40° Beaumé, or with a strong solution of chromic acid, or with acetic acid five parts, fuming nitric acid one part, diluted as may be necessary with distilled water.

The term "etching solution" is also applied to the solution of glycerine, with other ingredients, such as liquor ammoniæ, calcium nitrate, sodium chloride, etc., used for damping the collotype plate. Again, "etching" is applied to the operation of spreading over the lithographic stone or zinc or aluminium plate a slightly acid gum solution, which prepares the surface for clean inking and printing, though it does not actually etch into perceptible relief. Such etching solutions for zinc contain a decoction of nutgalls and phosphoric acid, and for aluminium phosphoric or hydrofluosilicic and other acids.

ETHER (Fr., *Éther sulfurique ;* Ger., *Aether*)

Synonyms, ethyl oxide, ethylic ether, sulphuric ether. $C_2H_5OC_2H_5$. Molecular weight, 74. Solubilities, 1 in 12 water; miscible in all proportions with alcohol, chloroform, benzole, etc. It is a limpid, very light, and volatile transparent liquid with characteristic odour and burning, sweet taste. It is made by distillation from sulphuric acid and alcohol. The vapour being very heavy and inflammable, ether should be kept in a well-stoppered bottle in a cool place. In large quantities it and its vapour are poisonous, the antidotes being an emetic or the use of a stomach pump, free supply of fresh air, ammonia, and artificial respiration. It may be prepared from either ethyl or methyl alcohol, the latter giving the so-called methylated ether which can be used for all photographic purposes. The specific gravity should be ·720. It is used for making collodion and varnishes.

In process work, ether is largely used for making collodion and collodion emulsion, the kind usually employed being methylated ether, sp. gr. ·720, washed and redistilled. It is also used for washing bitumen to increase its sensitiveness, and with alcohol as a solvent for bitumen in a process for graining the plate by reticulation of the film.

ETHOXY LIMELIGHT

Limelight produced by raising a spot on a cylinder of lime to a state of incandescence by means of a non-luminous flame of mixed ether vapour and oxygen. The mixture is prepared in a saturator (*which see*). Oxyhydrogen is a corresponding term indicating that a mixture of hydrogen and oxygen is burnt.

ETHYL ALCOHOL (*See* "Alcohol.")

ETHYL OXIDE (*See* "Ether.")

ETHYLIC ETHER (*See* "Ether.")

EURYSCOPE

Under this name Voigtländer and other opticians have issued lenses of the rapid rectilinear type, of intensities varying from *f*/4·5 to *f*/7. Similar lenses were issued by Ross as "Universal Symmetricals" and by Dallmeyer as "Extra Rapid Rectilinears." The rectilinear portrait lens of the latter maker was really a euryscope with an aperture of *f*/3. Slower forms of euryscope for wide-angle work, copying, etc., have also been made. Their greatest intensity varies from *f*/9 to *f*/15.

EVAPORATING DISH

In wet collodion photography this is a most important utensil for evaporating the silver bath when it has become deteriorated by use or by impurities. Usually the silver bath is boiled to evaporate about half the volume of solution, and then made up to strength again with distilled water and additional silver nitrate. Any alcohol and ether is thus driven off, and the iodising salts dissolved out of the collodion film are reduced in proportion to the volume of

Porcelain Evaporating Dish

the new solution. Amongst English and Continental workers the common laboratory form of porcelain basin is used, the bottom, outside, to which the greatest heat is applied, being left unglazed. It is best to embed the basin in a sand bath to avoid fracture by the application of direct heat. In America stamped enamelled iron dishes, called Agate ware, are largely used without any apparent drawback, and of late many English workers have taken to using cast-iron enamelled dishes. A good way of testing for faults in the enamel is to fill the enamelled vessel with copper sulphate. The acid will attack the iron wherever it can reach it through the small pores, and little beads of copper are deposited in small spots, gradually increasing in size until they become plainly visible. Such dishes are obviously unsuitable.

EVERSET SHUTTER (Fr., *Obturateur toujours armé, Obturateur automatique;* Ger., *Selbstthätiger Verschluss*)

Any shutter that does not require setting before an exposure can be made. An everset shutter is an obvious advantage, since an unexpected opportunity of photographing a moving object might be lost even in the short time occupied in setting the shutter.

EXCITING

The old and practically obsolete name for sensitising.

EXPANSION OF PAPER (*See* "Paper.")

EXPANSION, REDUCING DENSITY BY (*See* "Reduction, Mechanical.")

EXPLOSIVE POWDER (*See* "Flashlight Powders.")

EXPOSING, METHODS OF

The usual methods of exposing dry plates in a camera are by means of a cap or shutter. The cap method was the original one, and although it is considered old-fashioned it still has advantages. In landscape work the cap may be made to serve as a lens shade by holding it above the front of the lens during exposure. The correct way to uncap a lens is to imagine that it is hinged to the top of the lens hood. The cap is loosened by twisting and the lower edge raised until it is clear of the lens, and replaced again when exposure is finished; in this way the cap not only serves as a lens shade, but, by raising and lowering at a suitable speed, one can give more exposure to the foreground than the sky, and at times obtain clouds on the negative which would be missing on account of over exposure if the sky had the same amount of exposure as the landscape.

By the judicious use of a cap one may picture a busy street as being empty, and such a method is sometimes handy when one desires a photograph of a building in a busy street without showing the traffic. The lens in such a case is stopped down to its very smallest extent, the smaller the better, so as to require a very long exposure, the longer the better; exposure is then made by a series of very brief exposures with a cap. Assuming, for example, that an exposure of one minute is considered to be necessary, the plate is exposed for two seconds and the cap carefully replaced, another two seconds is given, and so on until the plate is considered to be fully exposed. The brief exposures will not be enough to picture moving objects, and only those which have remained still during the greater part of the minute will show when the plate is developed.

Shutter exposures are invaluable in cases of portraiture, and of course absolutely necessary for instantaneous work, as the quickest "off and on" cap exposure possible is estimated to be one-fifth of a second, but in the majority of cases it is nearer half, or even a whole, second. Silent-working shutters, preferably those which work inside the camera, are the best for portraiture, as those which work noisily and outside the camera are apt to startle the sitter, or otherwise attract attention at the wrong time. Children, for example, when posed in a position looking away from the camera, will often turn their heads when hearing the click of the shutter. When exposing for portraits and giving a time exposure with a roller blind shutter, it is a good plan to pull the cord gently so as to raise the blind and to release it before it reaches the half-way click, at which it remains open; the spring will pull the blind down again if the click is not passed, and in this way an absolutely silent exposure may be made. For exposures for self-portraiture, printing, enlarging, etc., see under those headings, and also "Exposure Tables."

EXPOSURE

It is scarcely necessary to emphasise the great importance of correct exposure in negative making; but it may be remarked that when the plate has been correctly exposed, all subsequent work is comparatively simple and straightforward, whereas with an incorrectly exposed plate all the subsequent operations are difficult and unsatisfactory, and the production of a good print is sometimes impossible.

The correct exposure of a plate depends on four varying factors: the subject; the light, which varies according to the season, the time of day, and the weather; the speed of the plate; and the "rapidity," or working aperture, of the lens.

In the earlier photographic days no attempt was made to work systematically from these four varying factors, but exposures were largely the result of guess-work. About 1880 the first attempts were made to systematise the data from which exposures were calculated, Dr. Scott's table of light values, and W. K. Burton's table of comparative exposures for different subjects being among the earliest examples of their kind. Dr. Scott determined the fact that the value of daylight varied in direct proportion to the height of the sun above the horizon. Consequently, in equally clear weather, exposures would require to be nearly four times as long in the middle of December as in June; and also at six o'clock in June exposures would be three times as long as at mid-day. Dr. Scott published a table, about 1883, giving proportionate figures for each hour of the day for the middle of each month. Although these figures were necessarily incomplete, the interval from one month to the next being much too long, this table proved to be of valuable assistance for many years.

Burton's tables provided a series of comparative exposures for different subjects—landscapes, marine pictures, interiors, and portraits—under normal conditions. It gave the exposures under the best possible conditions, and these had to be multiplied by the figures given in Dr. Scott's table for all times excepting mid-day in June. (*See also* "Exposure Tables.")

The most modern method of determining the duration of an exposure is by means of a meter. (*See* "Exposure Meter.")

In process work, and colour work, the lengthening of exposure due to prisms, mirrors, colour filters, or ruled screens becomes an important consideration. The larger the prism the more light is absorbed. With a 3-in. prism the exposure in the case of wet collodion work and enclosed electric arc light is increased by about 2¼ times; but this would not be true, for example, with an orthochromatic plate and green filter. Mirrors when in best condition do not greatly affect the exposure, but they will do so as they become tarnished and scratched. The ratio of exposures for colour filters should be determined by photographing black, white, and a scale of neutral greys, which should come alike on all three negatives. Ruled screens increase the exposure by about one-fifth, and as small stops are used the exposure will be much longer than in ordinary negative making, though proportionately the same. The nature of the "copy" (the original) influences the exposure in half-tone work. A deep red toned print will require the longest exposure.

EXPOSURE, EFFECT OF TEMPERATURE ON (*See* "Desiccated Dry Plates.")

EXPOSURE, INCORRECT

Correct exposure is the basis of all successful work in photography. But in some subjects, especially those with moving objects or very dark interiors, it may be impossible to expose sufficiently long; and occasionally errors of judgment may lead to both under- and over-exposed plates.

Incorrectly exposed plates can always be more successfully treated if the error is known before development is begun than if it is only recognised when the operation has made considerable progress. Under-exposure is the more difficult to treat, as there is insufficient light-action. If the subject is one that is deficient in contrast, or exposed in a dull light, the best method is prolonged development either in a normal solution, or in one containing the normal amount of developing reagent and excess of alkali. If the subject is strong in its contrasts of light and shade, prolonged treatment in a normal solution considerably diluted, or in a diluted solution with extra alkali added, is the only satisfactory method. The diluted solution lessens contrasts considerably; and it allows prolonged development without obtaining much strength in the light tones. Detail is obtained without density, and greater softness results than can be obtained by any other method. If the resultant negative is still too harsh, the methods given under the headings "Hard Negatives," "Harmonising Contrasts," etc., must be adopted.

Over-exposure within moderate limits comes within the latitude of the plate (*see* "Latitude in Plates"), and requires no special treatment, provided that the subject is one of good contrast of light and shade. If a plate has received an exposure from one and a-half times to twice the normal amount, development may be normal; and though the plate will look very strong, and different from one that has been correctly exposed, the resultant print will be little, if any, inferior to that yielded by a normally exposed plate. The time of printing will be much longer, and that will be the only difference. In moderate over-exposure in subjects deficient in contrast, for copying, etc., the only efficient means of correcting over-exposure in development is by treating it throughout by a modified solution. Potassium bromide may be added to a normal developer in any quantity up to 2 grs. to each 1 oz. of solution; or a more concentrated developer may be employed, and 3 grs. or 4 grs. of bromide added to each 1 oz.

Another method of working is to develop either with a normal or a concentrated solution until the extreme shadows begin to veil; then stop development and fix the plate, afterwards intensifying to bring it to full printing strength.

EXPOSURE INDICATOR (Fr., *Marquer automatique, Compteur, Enregistreur;* Ger., *Zählvozzichtung, Plattenzähler*)

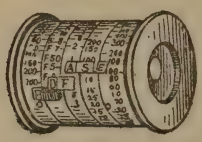
A mechanical contrivance fitted to magazine cameras to indicate the number of plates that have been exposed. Usually, the number of the plate in position for the next exposure is made to show at a small opening, directly the previously exposed plate is moved out of the way by the changing arrangement. One pattern has the numbers of the plates engraved on a metal wheel inside the camera, which is moved round one step by the action of the changing lever or handle, each time this is worked. There are other patterns.

EXPOSURE METER (Fr., *Photomètre, Lucimètre, Actinomètre;* Ger., *Expositionsmesser, Belichtungsmesser, Aktinometer*)

An instrument for ascertaining the necessary duration of exposure when taking a photograph.

The terms "exposure meter" and "actinometer" are often used interchangeably, but the latter refers to an appliance for simply testing the actinic power of light, whereas the former means an instrument that not only does this, but indicates also the exposure requisite under such conditions, with any given subject. While an exposure meter may be an actinometer, an actinometer is not an exposure meter. The term actinometer now tends to be restricted to appliances used for finding the light value when printing, as in the carbon and similar processes, where no visible image is at first obtained.

Of the many different kinds of exposure meters proposed the best are those that provide for an actual test of the light intensity; among these may be mentioned the Watkins and the Wynne



A. Watkins' Standard Exposure Meter

devices. The Watkins Standard Exposure Meter A has an enclosed chain pendulum for counting seconds or half-seconds, the cap or lid shown on the left forming, when removed, the weight of the pendulum. At the opposite end is an opening under which runs a coil of sensitive paper, which may be pulled out through a slot as required, in order to expose a fresh portion under the aperture. To use the meter, a new piece of paper is brought into position and quickly covered with the thumb, pointing the meter towards the source of the light that falls on the object to be photographed. The pendulum is then started swinging, and the finger

B. Watkins' Watch-form Exposure Meter

C. Wynne's Watch-form Exposure Meter

at the same time removed from the test paper. The number of seconds taken by the paper to darken to the depth of the standard tint, as painted in the circle beside the opening, is now carefully counted. The pointer P is then set against the plate speed number, the pointer D to the diaphragm number, and the pointer A to the actinometer time just obtained, when the correct exposure will be indicated by the pointer E. When the light is weak, or with specially dark subjects, the exposure of the camera and the meter may be carried out simultaneously, a second tint being provided, which the sensitive paper takes only one-quarter the time to match. This instrument is very complete, and permits of special calculations for other than ordinary subjects, such as enlarging, copying, etc.

A simpler form of the Watkins meter B resembles a watch. Fresh paper is adjusted under the opening by rotating the back of the case, and the diaphragm number on the inner ring is set against the plate speed; the required exposure will then be found against the actinometer time.

Wynne's "Infallible Exposure Meter" C also resembles a watch. A small disc of yellow glass (not shown in the illustration) is cemented to the revolving dial to cover the sensitive paper until it is wanted. It is thus possible to see to adjust fresh paper under the aperture without its being prematurely exposed to light, and to have it always ready by merely sliding aside the yellow disc. The Wynne meter has the valuable feature of showing at once the necessary exposure with all the different stops. A table is supplied with the meter assigning to the various makes of plates a speed number, which represents also a diaphragm number. To use the meter, the actinometer time on the inner ring, as found with the sensitive paper, is set against the plate speed on the outer circle. Against each of the diaphragm numbers on the latter will then be indicated the correct exposure. Obviously, if a stop corresponding with the plate speed number is used, the exposure will be identical with the actinometer time, and the camera and meter may be exposed simultaneously.

EXPOSURE NOTEBOOK (Fr., *Registre des expositions*; Ger., *Expositionsbuch*)

A notebook specially ruled for entering full particulars of each exposure made, for the after identification of the different negatives, or in order that any particular plate may receive individual treatment. Spaces are usually provided for details of subject, date, time, light, plate, number of slide, lens, stop, exposure, etc.

EXPOSURE, OVER- (*See* "Exposure, Incorrect.")

EXPOSURE TABLES

Tabulated series of comparative exposures for different subjects, variations in the actinic value of the light due to the season, and the different lens apertures and plates. They materially assist experienced workers when attempting unusual subjects; to the inexperienced they are extremely valuable, rendering the problem of exposure comparatively easy.

Of the many tables that have been produced, attention will here be directed to the series designed by Henry W. Bennett, these comprising a table of comparative exposures for different subjects, and a diagram and table of the variation in the value of the light due to the season of the year and the time of day.

Exposures for lens aperture f/16, plate 200 Hurter and Driffield, and the best possible conditions of light, etc., at mid-day in June:—

TABLE I

	Open-air Subjects	*Second*
Clouds		$\frac{1}{10}$
Boats at sea, distant		$\frac{1}{32}$

	Second
Boats at sea, near	$\frac{1}{50}$
Sea beach, waves, etc.	$\frac{1}{25}$
Landscapes:—	
Open common; or open subject with no strong objects	$\frac{1}{10}$
Average landscape: cottages or trees in prominent position	$\frac{1}{5}$
Trees in full leaf near camera	$\frac{1}{4}$
Trees in full leaf very near; part of trees only included in picture	$\frac{1}{2}$
Woods: photographs taken under strong foliage	1 to 5
Buildings:—	
Large buildings, general views	$\frac{1}{12}$
Cottages, small buildings	$\frac{1}{8}$
Street scenes	$\frac{1}{8}$
Narrow streets	$\frac{1}{4}$
Details of buildings	$\frac{1}{8}$ to $\frac{1}{4}$
Portraits:—	
Group or full-length figure	$\frac{1}{2}$
Head and bust	1
Still-life, flowers, etc., full-size	2 to 8
Larger objects, according to distance	$\frac{1}{4}$ to $\frac{1}{2}$
Interior Subjects	
Cathedrals and churches:—	
Nave or general view	45 sec. to 2 min.
Aisles, white glass windows	1 to 3 min.
Aisles, stained-glass windows	2 to 7 min.
Choir	4 to 15 min.
Crypt	10 to 60 min.
Ordinary rooms in modern houses	1 to 3 min.
Workshops	30 sec. to 1 min.
Rooms or workshops with skylights	10 to 20 sec.
Portraits in well-lighted room	10 to 25 sec.
Still-life, flowers, etc., full-size, near window	10 sec. to 1 min.

All the above times are sufficient to secure a fully-exposed plate. The boats at sea described as "near" are those that nearly fill the plate; those called "distant" are small in relation to the size of the picture. In the landscape subjects described as "open common," etc., are included all those that have no object with any depth of shadow within one hundred feet. Small bushes, lower than the camera, can be disregarded, as the camera, in looking downward, photographs them from above, the direction in which the light reaches them. In all landscape work, heavy foliage will require a longer exposure than any other subjects at the same distance, on account of its colour and strong deep shadows.

In all the interior subjects, a range of exposure is given. The shorter is for a well-lighted subject with large and unobstructed windows, the longer for one that is comparatively dark, with small windows or those seriously obstructed by outside objects. Dark woodwork in churches, especially if near the camera, will always necessitate a longer exposure than if the subject consists of light-coloured stone. In domestic interiors, the same principle regarding windows applies equally; and the colour of the walls and the furniture will also affect the exposure. In the case of an unfurnished room, the exposure may be reduced to half that given in the tables. The exposure for flowers and still-life subjects will be influenced by the colour, the degree of contrast, and also by the manner in which the light from the window falls on it.

These exposures, being correct for the best possible light in June, must be multiplied by the figures obtained from the graph (called "Table II."), in which the thicker horizontal lines represent the hours and the fine horizontal lines quarter-hours. The fine vertical lines correspond to intervals of five days for each division, the dates being given under every alternate line. It is practicable to read off the correct figure for any day, and for any time in the day. Each thick curved line has its multiplying figure shown on it. This figure is indicated for any date and time by the point at which these curved lines cross the horizontal and vertical:—

TABLE II

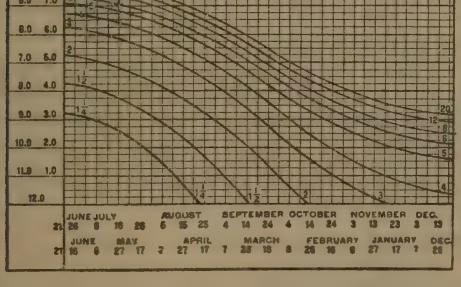


TABLE III

VALUE OF DAYLIGHT THROUGHOUT THE YEAR

a.m.	*p.m.*	*May 31 to July 10*	*May 20 & July 20*	*May 5 & Aug. 5*	*Apr. 20 & Aug. 20*	*Apr. 5 & Sept. 5*	*Mar. 20 & Sept. 20*	*Mar. 5 & Oct. 5*	*Feb. 20 & Oct. 20*	*Feb. 5 & Nov. 20*	*Jan. 20 & Nov. 20*	*Jan. 5 to Dec. 5*	*a.m.*	*p.m.*
12.0		1	1	1	1½	1½	1½	2	2½	2½	3	4	12.0	
11.0	1.0	1	1	1½	1½	1½	2	2½	3	3½	4	4½	11.0	1.0
10.0	2.0	1	1½	1½	1½	2	2	3	4	4	5	6	10.0	2.0
9.0	3.0	1½	1½	1½	2	2½	3	4	5	8	10	12	9.0	3.0
8.0	4.0	1½	1½	2	2½	3	4½	6	12				8.0	4.0
7.0	5.0	2	2	3	4	5	8	20						
6.0	6.0	3	3	4	6	12								
5.0	7.0	5	6	10	20									
4.0	8.0	20												

In Table III. it is only practicable to give multiplying figures for each hour and for every fifteenth day. The variations for intervening times and dates can be estimated. This daylight table disregards the effect of the weather. When the light shows any appreciable departure from the best for the time of year, the exposure should be multiplied by 2; if the weather is dull, multiply by 3; and if very dull or gloomy, by 4 or 5.

These exposures are for a plate having a speed of 200 H. and D. Most modern rapid plates are about this speed, but the makers give the rapidities in almost all cases. The exposure for other plates will be directly proportionate to their

rapidity; thus a plate 100 H. and D. will require twice the exposure of one having a speed of 200 H. and D.

These exposures are for *f*/16, a medium aperture. The relative exposures for other apertures are given in Table IV.

TABLE IV

Value of Diaphragm Apertures

f/5·6	*f*/8	*f*/11	*f*/16	*f*/22	*f*/32	*f*/45	*f*/64
⅛	¼	½	1	2	4	8	16

The exposure for any subject is first found from Table I.; this is multiplied by the time value from Table II. or III.; the result is multiplied by 2, 3, etc., if dull weather, and finally the total is multiplied by the stop value from Table IV. Otherwise expressed:—

Subject × Time value × Weather × Lens aperture
Table I. Table II. or III. Table IV.

The result being the exposure required

Two examples will render the method of working more easily understood. (1) For open country lane with cottages in the mid-distance, September 14, 2 p.m., a fine, clear day, stop *f*/32, plate 200 H. and D.:—

Subject	Time: Sep. 14 2 p.m.	Weather	Stop *f*/32	Exposure
⅛ sec.	× 2 ×	1	× 4	= 1 sec.

(2) A cathedral aisle, well lighted by stained-glass windows, April 17, 10.30 a.m., slightly dull [2], lens aperture *f*/22, plate 200 H. and D.:—

Subject	Time: Ap. 17 10.30 a.m.	Weather	Stop *f*/22	Exposure
2 min.	× 1½ ×	2	× 2	= 12 min.

Instead of using Table II. or III. and multiplying again for the weather, a meter may be substituted as a means of measuring the intensity of the light. The multiple of the unit time that is required for darkening the sensitive paper to match the standard tint is the figure to be used in multiplying the unit exposure obtained from Table I. The meter should always be held in a vertical position, facing the camera. As an example, the same data may be taken as in No. 1 illustrating working from Tables I. and II. A country lane with cottages, September 14, 2 p.m., stop *f*/32, plate 200 H. and D. Assume that a Wynne meter is used to test the light, the unit time for matching the painted tint being four seconds. It is held vertically, facing the camera, and the time required for matching the tint is eight seconds, twice the unit time.

Subject (Table I.)	Meter (units)	Stop *f*/32	Exposure
⅛ sec.	× 2 ×	4	= 1 sec.

A meter can be used in a very simple manner for determining the exposure of objects within twenty feet of the camera, by giving a definite proportion of the time that the paper takes to darken to the standard tint. The Wynne standard tint requires four seconds, the Watkins standard eight seconds, and the lighter of the two tints supplied with the Watkins Bee meter four seconds for matching with the sensitive paper in the best possible light. Consequently, in the following table, different proportionate figures must be employed according to the meter used.

To use this table, which is very useful for still-life, flowers, portraits, animals, machinery, etc., the meter is held close to the subject in a vertical position, facing the camera. The actual time that the paper takes to match the standard tint is noted, and a definite proportion of this time is the correct exposure without regarding it as a multiple of the standard time. This proportion varies according to the distance of the subject from the camera.

TABLE V

The exposure will be the following proportion of the actual time that the meter paper requires to match the standard tint:—

Distance of subject from camera	*Wynne and Watkins Bee light tint*	*Watkins standard tint*
3 feet	one-half	one-fourth
5 ,,	one-fourth	one-eighth
10 ,,	one-eighth	one-sixteenth
20 ,,	one-sixteenth	one-thirty-second

These exposures are for *f*/16, and a plate 200 H. and D.

These exposures are for objects of medium colour; for very dark subjects the exposure should be doubled; for very light, it may be reduced to one-half.

Two examples will illustrate the method. A portrait, head and bust only, is being taken in a garden. The sitter is about five feet from the camera, and a Wynne meter, held close to the sitter and facing the camera, requires four seconds to match its standard tint. The exposure for *f*/16 and a plate 200 H. and D. will be one-fourth of this time = 1 second.

A small machine is being photographed in a workshop, the same plate and stop *f*/32 being employed, and the machine being about ten feet from the camera. The day is dull, the workshop not well lighted, and the meter, placed on the machine while the camera is being arranged and the image focused, requires fourteen minutes to match the standard tint. One-eighth of this time for ten feet distance, one minute and three-quarters, multiplied by 4 for *f*/32, gives 7 minutes as the exposure required.

EXPOSURE, UNDER- (*See* "Exposure, Incorrect.")

EXPRESSTYPIE

A process of making grained half-tone blocks, invented by Cronenberg. It consists in the use of a grained screen, placed in contact with a gelatine dry plate so as to make a grained negative. This is printed on to zinc or copper in the usual way. The grain is of a reticulated character resembling collotype.

EXTENSION, CAMERA (Fr., *Extension*; Ger., *Ausdehnung*)

The distance between lens and plate, or the length to which the bellows will rack out. (*See* "Double Extension" and "Camera.")

Also the name given to an accessory for lengthening this distance, when the bellows do not rack

out far enough for the special work in hand. There are many different kinds of camera extensions, or "adapters," for this purpose, some fitting on the front of the camera, others at the back.

EXTERIORS, PHOTOGRAPHING

The general technical considerations that have to be observed in photographing exterior views of buildings, etc., are given under the heading "Architectural Photography." There are, however, several special considerations which cannot apply in the same manner in interior work. Speaking generally, a long-focus, rather than a short-focus, lens should be employed. At times there are advantages in using a short-focus lens for a comprehensive view of a high building, but in small details or portions the longer focus is always preferable when practicable. Of course, there are many cases where limited space or other conditions render it impossible to use any other than a wide-angle lens. There is one respect in which a wide-angle lens assists the photographer to secure an effect that cannot be obtained by any other means. In photographing a high building from the near point of view necessitated by a wide-angle lens, the impression is conveyed of looking upwards in a manner that cannot be given by any photograph taken from a more distant point. The effect is realistic.

Whether photographing a complete building or a small portion or detail, an oblique view should practically always be taken. A square front view is like an architect's drawing; it is never satisfactory, as it fails to give a fair impression. An oblique view gives at once a good impression of the relief and the form of the building or detail. It conveys the impression of solidity, and not simply the outline of the front elevation. Sunshine is very effective, and very useful in giving relief as well as good effect. More especially is this the case with large subjects; small details are frequently more satisfactory in diffused light. Very fine effects can sometimes be obtained by taking a photograph when the sun is shining almost along the surface of the subject, very slightly in front. The long cast shadows from projecting details are strikingly effective. A liberal proportion of foreground should be included in any pictorial view of a building, or doorway, or similar detail. And where possible, a foreground with lines running obliquely into the picture should be chosen. It is the most simple and telling manner of conveying the impression of the space that exists between the object and the observer. As in interior work, the point of view, the lighting, and the general conditions should be chosen so as to show in the most effective manner the character, the quality, and the special features of the architecture photographed.

EXTRA-FOCAL DISTANCE, OR "E.F.D."

The distance between lens and object, and lens and image, *minus* the focal length of the lens. The greater E.F.D. equals focal length multiplied by ratio. The lesser E.F.D. equals focal length divided by ratio.

EYE LENS

The lens, or combination of lenses, of an eyepiece which receives the image from the field lens and conveys it to the eye, as explained under the heading "Eyepiece."

EYEPIECE (Fr., *Oculaire;* Ger., *Okular*)

The lens, or combination of lenses, which receives the image from the microscope objective and conveys it to the eye. The best known types of eyepieces are the Huyghenian, the Ramsden, and the Kellner.

The Huyghenian, which is the most popular, is a negative combination composed of two plano-convex lenses separated by the distance of half the sum of their foci. The lower lens of an eyepiece, that nearest the objective, is known as the field lens, and the other is the eye lens. A stop is placed between the field and eye lens at the principal focus of the latter.

The Ramsden, which is a positive and achromatic eyepiece, is a combination of two plano-convex lenses with their convex surfaces inwards. This form is especially useful for micrometric purposes. The Kellner eyepiece is now rarely used; it gives a very large field, but the definition is not equal to that of the Huyghenian. The eye lens is a combination of a biconvex (field lens) and a biconcave lens (eye lens).

The projection eyepiece, as its name implies, is designed exclusively for lantern and photographic work. The field lens of a projection eyepiece consists of a plano-convex lens, the eye lens being a biconvex combination of three lenses. The field of this eyepiece is very limited, but it gives fine definition; the magnification is small, from 2 to 6 diameters. The compensating eyepiece is designed to be worked in conjunction with apochromatic objectives. This eyepiece derives its name from being over-corrected to compensate for the under-correction of the apochromats. The compensating eyepiece works well with high-power, but indifferently with low-power, achromatic lenses. The eye lens of the compensating ocular is plano-convex and the field-lens a biconvex triplet, the eye lens and field-lens being placed in close juxtaposition.

There are no universal standards for either diameter or magnification of eyepieces. The Royal Microscopic Society has adopted four standard sizes for eyepieces—namely, No. I. 0·9173 in. (23·3mm.); No. II. 1·04 in. (26·416 mm.); No. III. 1·27 in. (32·358 mm.); No. IV. 1·41 in. (35·814 mm.). The variety of methods of classifying the initial magnification or power of an eyepiece is even more unsatisfactory than the lack of uniformity in size. In most English eyepieces the initial magnification is indicated by letters A—E, A representing the lowest power listed by the particular firm, giving a magnification of 4 or 6 diameters; the initial magnification of E would be from 12 to 20. On the Continent figures, not letters, are used to classify the power of the ocular, but they give little clue to the magnification.

EYEPIECE, FOCUSING (*See* "Focusing Magnifier.")

F

"F" NUMBERS

A popular method of marking diaphragms or stops, the smaller *f* or the capital letter being used with the number, as, for example, *f* 8, *f*11, etc. (For full particulars of measuring, relative values, etc., *see* under the heading "Diaphragms.")

FABRICS, DARK-ROOM

Canary, orange, or red translucent cloth, used instead of coloured glass for screening the light in dark-room illumination. They are more serviceable when used with artificial light, as sunlight causes them quickly to fade and become unsafe. The canary fabric is generally used for slow bromide papers; the orange for rapid bromide papers, lantern plates, and slow dry plates; and the red for rapid dry plates. Fabrics are, as a rule, quite as safe as glass, but pinholes must be watched for, and the fabrics not wetted in any way or exposed to strong sunlight.

FABRICS, PRINTING ON

Fabrics already sensitised for the bromide and platinotype processes may be purchased, and they are used in the same way as bromide and platinotype papers. Fabrics are easily prepared for photographic printing, and the blue-print process is perhaps the simplest. The fabrics mostly employed are cottons, linens, silks, nainsooks, etc., but silk that has been weighted with mineral matter is unsuitable; the finer the material the better. The fabric needs to be thoroughly washed in hot water, ironed, and, to prevent the image from sinking into the material, it should then be well sized, a suitable size being—

Arrowroot	80 grs.	8 g.
Gelatine	33 ,,	3·3 ,,
Alum	18 ,,	1·8 ,,
Water to	20 oz.	1,000 ccs.

The fabric is immersed in this solution for about five minutes, pinned down on to a flat board, and dried before a fire, it being then somewhat stiff. The ammonio-citrate and ferricyanide sensitising solution (*see* "Blue-print Process") is then brushed over it, and, after drying, it is ready for printing upon. Printing, washing (fixing), etc., are exactly as described for blue prints upon paper. The printed fabric will not withstand washing with soap and water, as the alkali destroys the blue image.

In order to get the best and brightest of blue prints upon fabrics, it is necessary to use a negative with strong contrasts—that is, one with clear shadows and dense high lights, and the negative should show broad effects of light and shade rather than an abundance of fine detail.

A process for the replacing of the blue ferro-prussiate image by various dyes was published in 1898 by Stewart E. Carter. Bleached cotton or linen is brushed over with a ferro-prussiate sensitiser, made as follows:—

A. Ferric ammon. citrate	164 grs.	164 g.
Distilled water to	1 oz.	500 ccs.
B. Potass. ferricyanide	164 grs.	164 g.
Water to	1 oz.	500 ccs.

A and B are mixed in equal parts. The sensitised fabric is exposed and washed just as a print upon paper. The blue print is next immersed in a weak solution of caustic soda (5 grs. to 1 oz. of water) for a few minutes, then washed in hot water, and placed for three minutes in a solution of 13 grs. of sodium phosphate in 10 oz. of water at a temperature of 170° F. (about 77° C.). This is followed by washing, first in cold water and then in hot water, after which the print is ready to receive the dye. A weak gelatine solution is made (glue size 24 grs., water 10 oz.) and heated to 160° F. (71° C.), and the prints moved about in it for about three minutes; from 3 to 5 grams per litre (1·3 to 2·2 grs. per ounce) of dinitroresorcin (resorcin green) is added, and the temperature raised to 180° F. (82° C.). As soon as the shade is considered full enough for a strong picture, remove to boiling water to wash out all unfixed dye. The high lights (whites) are next cleared in a bath of neutral soap (used at a temperature of 160°F., 71°C), and the print again washed in hot water and finally in cold. Other dyes may be used in place of the green named. Gallo-cyanine gives blue and violet; alizarin gives purple, and also a brown sepia. The original blue print may be toned, but the dye method, although rather troublesome, gives the more pleasing effects.

Carbon prints may be transferred to any kind of fabric. This must be washed, dried, ironed, and given several coats of the following sizing mixture, allowing to dry after each coat:—

Cooking gelatine	2 oz.	133 g.
Sugar	1 ,,	66·5 ,,
Glycerine	1 ,,	66 ccs.
Chrome alum	15 grs.	2 g.
Barium sulphate	4 oz.	266 ,,
Water to	15 ,,	1,000 ccs.

Dissolve by heat and mix thoroughly. Transfer the carbon tissue thereon in the usual way. (*See* "Carbon Process.")

Fabrics can be sensitised and used as ordinary P.O.P. First soak the washed and dried fabric in the following size for about three minutes:—

Gelatine	100 grs.	10 g.
Common salt	100 ,,	10 ,,
Magnesium lactate	100 ,,	10 ,,
Water to	20 oz.	1,000 ccs.

Dissolve by aid of heat and then well mix; after coating the fabric allow it to dry thoroughly. The sized fabric is then sensitised by soaking for three minutes in—

Silver nitrate .	25 grs.	52 g.
Distilled water to .	1 oz.	1,000 ccs.

The fabric is next immersed for one minute in—

Citric acid .	50 grs.	5 g.
Sugar .	50 „	5 „
Water to .	20 „	1,000 ccs.

and dried in the dark. The sensitive fabric is then printed upon, toned, fixed, and washed exactly as ordinary P.O.P.

An easier method of coating fabric with a silver solution is the following: A salting or sizing bath is first made by rubbing up 180 grs. of arrowroot or dextrine in a little cold water until a smooth paste results; make this up to ¾ pint with boiling water. If the mixture does not at once become gelatinous it should be kept hot (not boiling) and stirred till it does. It should then be allowed to cool a little, and 160 grs. of ammonium chloride dissolved in about 4 oz. of water added to it. The mixture is applied while warm to the washed and ironed fabric, which is then dried and sensitised in the following bath:—

A. Citric acid .	25 grs.	50 g.
Distilled water .	½ oz.	500 ccs.
B. Silver nitrate .	60 grs.	125 g.
Distilled water .	½ oz.	500 ccs.

Mix the two solutions. To sensitise the fabric use a Buckle or Blanchard brush. Pin the fabric to a flat board, pour upon it a little of the silver sensitising mixture rapidly and evenly, spread it over the entire surface, and dry in the dark. The fabric is printed upon as though it were P.O.P., toned with an acetate and gold toning bath, and fixed and washed like paper. It is desirable after washing and before toning to pass the print through a weak solution of sodium chloride (common salt), which gives reddish brown tones, or of sodium carbonate, which gives brownish purple tones. (*See also* "Diazotype," "Indigo Printing," etc.)

FACTORIAL DEVELOPMENT (*See* "Development, Factorial.")

FACTORIES, PHOTOGRAPHING IN

Taking photographs in factories or workshops presents difficulties from several independent causes. The first is that work in progress cannot always be stopped while the exposures are made, and the consequent movement cannot always be prevented. Then machinery and shafting in constant motion introduce the serious element of vibration, and, in addition, smoke and moisture are inseparable from some kinds of work, increasing the difficulties of securing good negatives. When the nature of the work will allow it, the negatives should be taken during the dinner-hour. The camera can be set, everything arranged as desired, the subject focused, and everything made ready for the exposure beforehand. Then the plate can be exposed under the best possible conditions. A small stop is almost always necessary for securing good definition throughout.

When figures have to be included and the work shown under its normal conditions, the case is different. The exposure must necessarily be short so as to avoid movement of the principal figures. Frequently, a large aperture is necessary in order to shorten the exposure sufficiently, and it may be quite impossible to secure the degree of sharpness in the different planes that the photographer would desire. In that case, the principal objects must be rendered as crisp and sharp as possible, and the other parts must simply take their chance. Considerable assistance may be given to the workmen that are included by the manner of posing. If they can be given a little support, by resting on a tool, or putting one of their hands on a machine, however slight the support may be, it will materially assist in avoiding movement during the exposure. A longer exposure can be given without appreciable movement. A single machine with one or two figures should cause no difficulty. In subjects of this kind, duplicate exposures should always be made.

Any windows that are in front of the camera and included in the picture should be covered during nine-tenths of the exposure, and, if possible, the covering should be outside. Windows in front of the camera, but not included in the picture, should be covered during the whole of the exposure, unless the lens can be shielded from them as described under the heading "Interiors, Photographing."

FADED NEGATIVES AND PRINTS, RESTORING

Faded prints are more commonly met with than faded negatives, but whichever is treated, success is more certain if the actual cause of fading is known (*see* "Fading, Causes of"). When negatives fade the trouble is usually due either to insufficient fixing or to insufficient or improper washing after bleaching with mercury for the purpose of intensification. During the year 1900 Sir William Crookes paid particular attention to the subject of restoring faded negatives—presumably those treated in the usual way and not intensified—and the following process is advocated by him. The faded dry-plate negative is soaked for three hours in distilled water, and then immersed for from ten to fifteen minutes (in the dark-room) in the following bath:—

Water .	1 oz.	500 ccs.
Pyro .	3 grs.	3 g.
Sodium metabisulphite	3 „	3 „
Sodium carbonate .	36 „	36 „
Sodium sulphite .	12 „	12 „

The plate is next well washed, immersed in an ordinary "hypo" fixing bath for half an hour, and then washed in running water for from four to six hours. It is then toned with gold, for which purpose two solutions are required, one of ammonium sulphocyanide (10 grs. to the ounce), and one of gold chloride (1 gr. to the ounce); for use, 1 oz. of each is taken and 8 oz. of water added; or, if desired, the complete bath may be made up as—

Water .	10 oz.	1,000 ccs.
Am. sulphocyanide .	10 grs.	2 g.
Gold chloride .	1 gr.	·2 „

The plate is immersed in this bath for about ten minutes and finally washed for half an hour and dried. The fixing in "hypo" can be omitted if so wished, although it is desirable. The gold toning bath has the property of precipitating gold on the image and rendering it of a blacker colour.

Negatives that have been intensified with mercury may fade quickly, and to restore them they should be treated with a solution of potassium sulphantimonate, commonly known as Schlippe's salt. The faded negative is first thoroughly soaked and then treated with 20 grs. of Schlippe's salt dissolved in 2 oz. of water, until the desired result is obtained; finally wash well.

The fading of prints has always been a troublesome matter. In the old days the necessity for thorough fixing and the complete removal of the "hypo" was not generally recognised, and the question of fading became so important that a committee was formed in May, 1855, to enquire into the causes, the Prince Consort contributing £50 to the expenses of the inquiry. Since then, of course, many improved papers have taken the place of the old ones, and different causes have arisen. Platinum prints are said never to fade, but nevertheless they sometimes appear to change their colour from the original pure black to a brownish or yellowish brown colour. According to Chapman Jones, such prints may be completely brought back to their original colour by unmounting and treating with a mixture of hydrochloric acid and chlorine water, made by adding a few drops of sodium hypochlorite solution to dilute hydrochloric acid (about one of acid to ten or more of water), until the odour of chlorine is distinctly noticeable. Neither hydrochloric acid nor chlorine water alone is effective, though each does something towards the desired end. Several other methods have been advocated, but all are more troublesome, and not nearly so effective.

The restoration of silver (printed-out) prints is at all times a very risky performance. If they are old and yellow, and of value, they should be copied—preferably through light blue glass—before any attempt is made to tamper with them, because of the risk of spoiling the originals. One process is to bleach the yellowed albumen print in a mercuric chloride solution as used for intensifying, well wash, and then to develop in an old hydroquinone or metol developer (without bromide), or preferably to immerse in a 5 per cent. solution of sodium sulphite, and finally wash well. This process is not reliable. An elaborate process of restoring silver prints, and one for which the inventor (H. Jandaurek) was awarded a silver medal in 1888, is as follows. Two solutions are required:—

A. Distilled water	35 oz.	1,000 ccs.
Sodium tungstate	608 grs.	5 g.
B. Distilled water	1 oz.	400 ccs.
Calcium carbonate (pure)	5 grs.	4 g.
Chloride of lime	1·2 ,,	1 ,,
Gold and sodium chloride	5 ,,	4 ,,

The B solution should be kept in a yellow bottle or in the dark for twenty-four hours. The faded prints are unmounted, well washed, and placed in 8 oz. of the A solution to which ¼ oz. to ½ oz. of B has been added. They should remain in this toning bath until they assume a good purple tone, and they are then well washed and fixed with "hypo" (1 oz. to 10 oz. of water) until all the yellowness has disappeared, which may take one hour or more; finally, they are washed well.

As stated above, all print restoration processes are more or less unreliable, and need to be used with great caution. Any details that have vanished from the faded print cannot be brought back, and all that the restoration process does is to strengthen the weak parts of the print, and as much as this can be done equally well by making a copy in a proper manner.

FADING, CAUSES OF

All silver images, whether negative or positive, are formed by metallic silver in an extremely fine state of division imbedded in a vehicle of albumen, gelatine, or collodion. Everyone knows how prone silver, even in the form of spoons and forks or ornaments, is to tarnish, and consequently it can be well understood how much more readily the metal in a finely divided state can be attacked. In many cases, particularly in that of prints, the fading is undoubtedly due to imperfect fixation or removal of the last traces of "hypo" or the hyposulphite of silver. It must not be overlooked that gelatine is a hygroscopic substance, and that "hypo" in the presence of moisture is decomposed, giving rise to sulphur compounds which readily attack the image. Whilst fading is not so commonly met with in negatives, it can still be detected sometimes, and it is then advisable to bleach the negative with a chlorising mixture, such as hydrochloric acid and potassium bichromate, wash well, and redevelop.

There is but little hope of saving a fading print, and care should be taken to ensure perfect fixation and thorough washing, the former being as essential as the latter. It will often be found that prints mounted on cards show fading more readily than those that are unmounted, and this may be due to the card containing "hypo" or some sulphur compound which is gradually decomposed by the mountant or moisture, and acts on the silver image. Frequently, too, prints—especially collodion prints—will fade in circular spots, and this can often be traced to small particles of metal, such as the bronze powder used for gilding the edges, etc., electrolytic action having been set up by the acid moisture in the air between the two metals. Varnishing negatives and prints is some protection. In the case of framed prints care should be taken to see that the backboard of the frame fits well, that the prints and mount are thoroughly dry before being framed, and that all round the edges, and over any cracks in the backboard, good stout brown paper is pasted or glued.

FAHRENHEIT THERMOMETER (*See* "Thermometer.")

FALLING FRONT (*See* "Rising Front.")

FALSE IMAGES, OR "GHOSTS" (Fr., *Images fausses;* Ger., *Falsche Bilder*)

Even the best doublet lenses sometimes show what is known as a false image or "ghost,"

when a bright object or light occurs in the picture. This is due to reflection of the bright object from the front surface of the back lens, and from this to the back surface of the front lens, whence it is again reflected towards the plate. In a properly designed lens, the distance apart of the glasses and the position of the stop are so arranged that the false image is diffused before it reaches the plate, and so is very rarely troublesome. To test for the presence of a false image, focus a gas flame or a lighted candle, placed at a distance from the camera equal to about eight or ten times the focal length of the lens. Cover the head with the focusing cloth, and bring the image of the flame into the centre of the ground-glass screen. If the camera is now turned slowly so that the image moves to one side, the ghost, if present, may on careful inspection be seen moving in the contrary direction, and exactly opposite the principal image. It very probably will not be in focus at the same time as the chief image, but it may usually be brought into focus by a slight movement of the screw, and will then be found to be distinguished from the primary image by being erect instead of inverted. This defect may often be cured by slightly altering the distance between the lenses, or by varying the position of the diaphragm, the false image being consequently spread over the whole of the plate and not allowed to come to a focus. (*See also* "Flare Spot.")

FALSE DISPERSION (*See* "Dispersion.")

FALSE PERSPECTIVE (*See* "Perspective, False.")

FARMER'S REDUCER AND INTENSIFIER

About the year 1883 Howard Farmer introduced what is undoubtedly the most widely used reducer. It consists of "hypo" and potassium ferricyanide in solution, and is sometimes referred to as the "ferricyanide" or "hypo-ferricyanide," but more frequently as the "Farmer" or "Howard Farmer" reducer. It will be found described under the heading of "Reducers."

Farmer's intensifier is not so well known. It is one of the "silver" processes, and will be found with others under the heading of "Silver Intensifier."

FEERTYPE

A printing process, patented by Dr. Adolf Feer in 1889, in which paper is sensitised with diazo-sulphonic salts of aniline, amido-azobenzol, benzidine, and their homologues, in conjunction with compounds of phenol, resorcin, or naphthol. The diazo compound is set free by the action of light, and forms a colouring matter; thus a coloured positive print is obtained from a negative. After exposure, the print is washed in water or dilute hydrochloric acid, by which means the unacted upon and unchanged preparation is removed. (*See also* "Diazotype.")

FERGUSON'S TONER

A copper toning bath for bromide prints. (*See* "Copper Toning.")

FERNS AND LEAVES, PRINTING FROM

Ferns and leaves make effective and decorative photographs which are easily produced without a camera, lens, or negative, the leaves being printed direct upon the sensitive paper. Lace may also be photographed in the same way. Either fresh, preserved, or skeletonised flowers and leaves may be used. A piece of plain glass should be placed in a printing frame of the desired size and the leaf laid flat thereon, the sensitive paper (any kind answers, although P.O.P. is preferable) coming next; the back of the frame is placed in position, and the whole put out to print in the usual way. When printed sufficiently, tone or develop, as the case may be, and afterwards fix and thoroughly wash. When the leaves are particularly moist it is advisable to place a thin sheet of celluloid—a clean film serves admirably—between the leaf and the paper in order to prevent the paper from becoming contaminated with the natural juices. Almost equally good results may be obtained from natural or skeletonised leaves, the difference being in the duration of printing. Bracken and virginia creeper leaves are particularly suitable, and a brief printing from fresh leaves gives the outline of the leaves only, the image appearing as white upon black. If, however, a reversal is wanted, the leaf may be placed in contact with a dry plate and a negative made which would produce a print showing black upon white. The longer the exposure the more light travels through the leaf, and the greater the detail obtained. New leaves when suitably printed give beautiful half-tones, because of the different densities of the various parts of the leaves; whereas skeleton leaves produce only black and white prints. Talbot, in 1836, used a fern leaf when he produced the first silver print on paper.

FERRIC AMMONIO-CITRATE (Fr., *Citrate de fer ammoniacale;* Ger., *Braune citronensäure Eisenoxydammoniak*)

Synonym, ammonium citrate of iron. $4Fe\,C_6H_5O_7\,3(NH_4)_3\,C_6\,H_5O_7\,3Fe\,(OH)_3$. Molecular weight, 2,030. Solubilities, 1 in 4 water, insoluble in alcohol. It takes the form of brownish red scales, and is made by dissolving freshly precipitated ferric hydrate in excess of citric acid and neutralising with ammonia. It is sensitive to light, and should be kept in the dark. It is used in conjunction with potassium ferricyanide in the iron printing processes.

Valenta has recommended a green salt, which is a mixture of neutral ammonium ferric citrate, acid ammonium ferric citrate, and ferric citrate, and has the formula $5FeC_6H_5O_7\,2(NH_4)_3\,C_6H_5O_7\,NH_4\,C_6H_7O_7\,2H_2O$. Molecular weight, 1,956. This occurs in bright, greenish yellow scales, and gives much more sensitive papers with purer whites than does the brown salt. It also is sensitive to light and must be kept in the dark.

FERRIC AMMONIO-OXALATE (Fr., *Oxalate ammoniaco-ferrique;* Ger., *Ammonium ferrioxalat*)

Synonyms, ammonium oxalate of iron, oxalate of iron and ammonia. $Fe_2(C_2O_4)_3\,3(NH_4)_2\,C_2O_4\,8H_2O$. Molecular weight, 892. Solubilities, 1 in 2·1 water, insoluble in alcohol. It occurs in bright green crystals, and is formed by

dissolving ferric hydrate in ammonium oxalate solution, evaporating and crystallising. It is decomposed by light into ferrous ammonium oxalate, and is used occasionally for blue prints, a formula being :—

A. Ferric ammonium oxalate . .	½ oz.	250 g.
Distilled water to	20 ,,	1,000 ccs.
B. Potassium ferricyanide . .	½ oz.	250 g.
Distilled water to	20 ,,	1,000 ccs.

Mix in equal parts just before use. It is also used in the cold-development platinum and the print-out platinum processes.

FERRIC AMMONIO-SULPHATE (Fr., *Sulfate de fer ammoniacale ;* Ger., *Schwefelsäure Eisenoxydammoniak*)

Synonyms, ammonium sulphate of iron. $Fe\,SO_4\,(NH_4)_2\,SO_4\,6H_2O$. Molecular weight, 328. Solubilities, 1 in 5 water, insoluble in alcohol. It occurs as pale greenish crystals, and is prepared by dissolving 139 parts of ferrous sulphate and 75 parts of ammonium sulphate in a minimum of water and afterwards crystallising. It has been suggested as a substitute for ferrous sulphate on account of its greater stability, and it has been used for developing wet plates.

FERRIC CHLORIDE (Fr., *Chlorure ferrique ;* Ger., *Eisenchlorid*)

Synonym, perchloride or sesquichloride of iron, iron trichloride. $Fe\,Cl_3\,6H_2O$. Molecular weight, 270·5. Solubilities, 1 in ·63 water, 1 in 4 alcohol, 1 in 4 ether. It takes the form of yellow crystalline lumps, which rapidly deliquesce in the air. It is prepared by dissolving iron wire in hydrochloric acid and oxidising with nitric acid. It has been recommended for reducing negatives, but it gives rise to yellow stains due to the formation of basic ferrous salts. Its chief use is as a mordant in etching half-tone and photogravure plates.

FERRIC OXALATE (Fr., *Oxalate ferrique ;* Ger., *Ferrioxalat*)

Synonym, iron sesquioxalate. $Fe_2\,(C_2O_4)_3$. Molecular weight, 376. Solubilities, very soluble in water, insoluble in alcohol. It occurs in greenish, glistening scales, which are extremely sensitive to light, and it is therefore usually preferred to mix it in solution and preserve in the dark. It is the most light-sensitive of any of the iron salts. It is used in the kallitype process, but its chief use is as the sensitive salt in the platinotype process. The following is the best method of preparing the normal ferric oxalate solution : Powder some ammonia-iron-alum, weigh out 500 grs. or 520 g., place in a tall cylindrical graduate, capable of holding 20 oz. or 1,000 ccs., and add 192 minims or 200 ccs. of liquor ammoniæ (·880), and an equal quantity of distilled water. Stir well for about five minutes, and allow to stand for a further five minutes. Then fill up with distilled water, stir well, and allow the precipitated ferric hydrate to settle down. Next decant or siphon off the clear supernatant liquid, and repeat the process until the wash water is no longer alkaline to litmus paper. Then allow the precipitate to settle till it occupies not more than 17 oz. or 850 ccs. Add 2,064 grs. or 215 g. of pure oxalic acid in powder, stir well, and allow to stand in the dark-room until the precipitate is completely dissolved. Now filter the solution, and wash the filter paper with distilled water so as to make the total bulk of the solution 20 oz. or 1,000 ccs. This forms the "normal iron solution" for platinotype, and contains 20 per cent. of ferric oxalate with about 1·2 per cent. of oxalic acid.

FERRIC PROTOACETATE (*See* "Ferrous Acetate.")

FERRIC PROTOSULPHATE (*See* "Ferrous Sulphate.")

FERRIC SALTS, PRINTING WITH

The light-sensitiveness of the iron (ferric) salts is the basis of a large number of printing processes, including chrysotype, cyanotype, kallitype, the sepia printing process, amphitype, the ink process, and platinotype. In all these the ferric salt is reduced by light to the ferrous state. The following table (due to Eder) shows the comparative light sensitiveness of the various iron salts :—

Ferric chloride and oxalic acid .	100
Ferric oxalate	89
Ammonium ferric oxalate . .	80
Potassium ferric oxalate . .	78
Ferric tartrate	80
Ammonium ferric tartrate. .	80
Ammonium ferric citrate . .	15
Ferric chloride and citric acid .	19
Ferric chloride and tartaric acid	25

Many of the inorganic ferric salts are comparatively stable to light, but in contact with organic matter are readily reduced, as in the case of ferric chloride with oxalic or citric acid. According to Abney the spectral sensitiveness of the iron salts is chiefly in the indigo blue, about G ½ F, and extends to E in the green and well into the ultra-violet.

Printing with salts of iron is known as the iron-printing or heliographic process. The four principal processes, each of which is described under its own heading, are : the blue print process (ferro-prussiate), white lines on a blue ground ; Pellet, blue lines on a white ground ; ferro-gallic, black lines on a white ground ; and brown line (better known as, and described elsewhere in this work under the heading of, "Kallitype"), white lines on a brown ground.

An interesting process of printing with a ferric salt is Shawcross's Amphitype (*which see*), in which advantage is taken of the fact that these salts have the property of attracting or repelling greasy inks. This is again shown in the black line "True-to-scale," or Ordoverax, process, where an undeveloped blue-print laid on a gelatinous surface will so affect the latter as to enable the lines to take ink while the other parts repel it.

The table on p. 239 (due to Eder) gives a very clear précis of the principal iron printing processes and the developers necessary to produce full vigour of the images, which as a rule are only faint. (See also separate headings.)

Sensitive salt	*Product of light action*	*Developer used to produce full vigour of image*	*Colour of image*	*Name of process*
Ferric oxalate, citrate, tartrate, etc.	Ferrous salt (ferrous oxalate), citrate, etc.	Potassium ferricyanide. (This gives insoluble Berlin blue with ferrous salts, but a soluble compound with ferric salts)	Blue	Cyanotype. (Gives white lines on blue ground from a tracing)
Ditto	Ditto	Potassium ferrocyanide. (This gives a blue precipitate with ferric salts, but a white with ferrous salts)	Blue	Pellet's process. (Gives blue lines on white ground from a tracing)
Ferric citrate	Ferrous citrate	Gold chloride. (Where the ferrous salt is formed metallic gold is precipitated)	Brownish	Chrysotype
Ferric oxalate	Ferrous oxalate	Potassium chloroplatinite. (Metallic platinum is precipitated where the ferrous salt is formed)	Black	Platinotype
Ferric oxalate	Ferrous oxalate	Silver nitrate	Brownish black	Kallitype or Argentotype
Ferric and cupric chloride	Cuprous chloride	Potassium sulphocyanide, followed by potassium ferricyanide. (The cuprous chloride is converted into brown cuprous ferrocyanide)	Red brown	Obernetter's process

FERRIC SESQUIOXALATE (*See* "Ferric Oxalate.")

FERRIC SODIUM OXALATE (Fr., *Oxalate de fer et de soude;* Ger., *Natriumferrioxalat*)

Synonym, sodio-ferric oxalate. $Fe\ (C_2O_4)_3\ 3Na_2\ C_2O_4\ 11H_2O$. Molecular weight, 976. Solubilities, 1 in 1·69 water, insoluble in alcohol. It occurs as large green crystals, unaffected by the air. It is prepared by dissolving ferric hydrate in acid oxalate of sodium. It is used in the printing-out platinum process.

FERRIC SULPHATE (Fr., *Sulfate ferrique;* Ger., *Ferrisulfat, Schwefelsäure Eisenoxyd*)

Synonym, sesquisulphate of iron. $Fe_2\ (SO_4)_3\ 9H_2O$. Molecular weight, 563. Soluble in water. It takes the form of greenish crystals, or, in the anhydrous form, it occurs as a greyish white powder. It has been suggested as a reducer, but it gives rise to yellowish basic iron salts in the film.

FERRICYANIDE OF COPPER (*See* "Copper and Potassium Ferricyanide.")

FERRICYANIDE OF POTASSIUM (*See* "Potassium Ferricyanide.")

FERRICYANIDE REDUCER (Fr., *Réducteur ferricyanure;* Ger., *Rothes Blutlangensalz Abschwacher*)

The action and use of this reducer are described under the heading "Reducers."

FERRIER AND SOULIER PROCESS

A method of making lantern slides and stereoscopic transparencies, invented by Ferrier in the early days of the albumen process of making positives upon glass. The method has been kept a trade secret, but is said to be a modification of the albumen positive process.

FERRO-CUPRIC PROCESS

An iron printing process devised by Obernetter about the year 1865. Paper is coated by floating on the following sensitive mixture:—

Water. . . .	100 parts
Copper chloride (crystals) .	10 ,,
Ferric chloride solution (sp. g. 1·5)	1 ,,
Hydrochloric acid . .	1 ,,

The paper is then dried and exposed in the same way as "blue-print" paper, a faint image being visible. Immediately after printing it is floated on the following developing mixture:—

Potassium sulphocyanide .	10 parts
Sulphuric acid . . .	1 part
Water. . . .	1,000 parts

To this is added 15 parts of the sensitive mixture given above. If the print is not developed immediately after printing the image is lost. Development at first should be by floating, and when the image has partially developed, the paper may be entirely immersed. The paper is afterwards well washed and toned. Red tones may be obtained by immersing the developed print in a 10 per cent. solution of potassium ferricyanide. For purple tones use—

Ferric chloride . .	1 part
Ferrous sulphate . .	2 to 2½ parts
Hydrochloric acid .	2 parts
Water. . .	10 to 50 parts

This bath will give a range of tones from red through violet and purple to a greenish black. Finally wash in weak hydrochloric acid.

FERRO-GALLIC PROCESS

A method of printing with ferric (iron) salts, giving a black image upon a white ground; known also as the black-line process and the Colas process. It is largely used by architects, engineers, etc., for multiplying drawings. The following mixture is made up, or larger quantities in proportion:—

Ferric chloride (syrupy)	30 grs.	60 g.
Ferric sulphate . .	15 ,,	30 ,,
Gelatine . . .	15 ,,	30 ,,
Tartaric acid . .	15 ,,	30 ,,
Water . . .	1 oz.	1,000 ccs.

Soak the gelatine in the water, melt by the aid of heat, and add the other ingredients. Coat paper in the way recommended for the blue-print process and dry in the dark. When dry, expose under negative or tracing till the ground is white and the lines appear yellow, and then immerse in the following developer :—

Gallic acid . .	20 grs.	4 g.
Oxalic acid . .	5 ,,	1 ,,
Water . . .	10 oz.	1,000 ccs.

till the lines are quite black ; wash, and dry by blotting off between clean blotting-paper and hanging up.

FERRO-GELATINE DEVELOPER

A solution of gelatine boiled with sulphuric acid so as to lose its setting power, used by Carey Lea as an addition to the wet-plate developer.

FERROGRAPHS (*See* "Ferrotype Process.")

FERROPRUSSIATE (*See* "Blue-print Process.")

FERROTYPE PLATES

Thin plates of metal coated on their face with a fine hard dark enamel. They were so called through being prepared as a basis for "ferrotypes," or collodion positives taken direct in the camera. (*See* "Ferrotype Process.") They have, however, another use in modern photography. A glossy-surfaced gelatine print may be squeegeed while wet on to a ferrotype plate in exactly the same manner as on to a sheet of plate glass. No preparation of the ferrotype plate is necessary beyond washing and polishing with a soft fabric, and when the prints are dry they leave the plate easily with a surface scarcely inferior to that produced by contact with glass

FERROTYPE PROCESS (Fr., *Procédé ferrotype;* Ger., *Ferrotypie*)

About the middle of the nineteenth century the term "ferrotype" was applied to the process introduced by Robert Hunt as "Energiatype" (*which see*), but that process was but little used, and the modern ferrotype is quite different.

Ferrotypes (known also as "tintypes") are pictures taken on sheet-iron plates varnished or enamelled on both sides, the picture side being the more carefully prepared. They are of American origin, having been introduced by J. W. Griswold in 1855, and were also known as "Melainotypes" before the title of ferrotype was generally adopted. It is believed that the earliest reference made to ferrotypes is in *Photographic Notes*, dated January 1, 1856, announcing the invention by a Prof. Smith, of Ohio, of a process of "producing a beautiful picture on a piece of common sheet iron, . . . equal to daguerreotypes, and much superior in some respects." The journal calls the pictures "Ferrographs."

Ferrotype pictures are positives produced by the wet collodion process, a black or chocolate enamelled iron plate being used as a support for the picture instead of glass. The latter needs backing up with black paper, velvet, or paint. The finished results have the same appearance in both cases, but the ferrotype image is reversed as regards right and left, and the process is therefore not suitable for general application. Everyone knows that this process has been widely used for portraiture by itinerant photographers, since by its aid they can take and finish a portrait in the space of a few minutes. The photographer generally takes particular care to arrange the sitter "full face," or in any other position in which reversal is not at first detected. For ferrotype work proper the operator must be within easy reach of his dark-room, as the plates are prepared immediately before exposure.

The process, in brief, is first to prepare the plate with collodion, sensitise in a silver bath, expose while wet, develop with an iron developer, and fix in a solution of potassium cyanide ; all formulæ and working details will be found under the heading "Collodion Process (Wet)."

The Dry Process.—The introduction of ferrotype dry plates has largely displaced the old-fashioned wet process ; itinerant photographers use them in conjunction with automatic cameras, which comprise arrangements for developing and fixing, thus obviating the use of the old portable perambulator-like dark-rooms. Ferrotype dry plates are bought in packets and used like other dry plates, but instead of yielding a negative on glass they give a positive direct upon the black iron or tin support. An example of the developers used for such plates is:

Sodium carbonate (pure)	4 ,,	200 g.
Sodium sulphite .	2 ,,	100 ,,
Hydroquinone . .	¼ ,,	12·5 ,,
Potassium bromide .	290 grs.	29 ,,
"Hypo" fixing solution (as below) . .	½ oz.	25 ccs.
Warm water to .	20 ,,	1,000 ,,

Allow to stand for two days and pour off the clear solution for use. In cold weather half the above quantity of bromide is required. After exposure, the ferrotype dry plate is developed until the high lights (which appear brown on a white background) and half-tones are well out, and the plate is then rinsed in water and fixed in a "hypo" fixing solution (sodium hyposulphite 4 oz., water 20 oz.). Development takes from eight to twelve seconds in hot weather, twelve to twenty seconds in a normal temperature, and twenty to sixty seconds in cold weather. After fixing (duration, ten to thirty seconds), the plate is rinsed for a few seconds and dried spontaneously or by gentle heat. It is next varnished, and then gives the appearance of having been produced by the wet collodion process. Sediment sometimes appears on the film after washing, particularly when over-developed, and gives the plate a fogged appearance ; it may be removed, before drying, with a pad of cotton wool.

A positive on a ferrotype plate is sometimes used by artists as a means of tracing from. Where a photograph is not to the correct scale a positive enlargement can be more rapidly made than a negative and print. As the image is reversed in relation to right and left, it becomes correct when traced over on gelatine by scratching the outline with a needle-point and filling with blacklead or other set-off powder, the gelatine being then turned over and rubbed down on to drawing paper or Bristol board.

AFTER A STORM

FERROUS ACETATE (Fr., *Acétate de fer;* Ger., *Ferroacetat*)

Synonyms, ferric protoacetate, acetate of iron. Soluble in water. $Fe(CH_3COO)_2$. Molecular weight, 174. It occurs as green crystals, and is obtained by dissolving iron in acetic acid. It was occasionally used in the wet plate days, and was then formed in solution by adding lead acetate to ferrous sulphate, when ferrous acetate was formed and lead sulphate precipitated.

FERROUS AMMONIUM SULPHATE (Fr., *Sulfate de fer ammoniacale;* Ger., *Schwefelsaures Eisenoxydulammoniak*)

Synonyms, ammonio-ferrous sulphate, Mohr's salt. $FeSO_4(NH_4)_2SO_4 6H_2O$. Molecular weight, 392. It takes the form of pale bluish green crystals. It is made by crystallising ferrous and ammonium sulphate. It was used in the old wet plate days as being a more stable salt than the ordinary ferrous sulphate. Seven parts of the double salt are equal to five of the ferrous sulphate.

FERROUS CHLORIDE (Fr., *Protochlorure de fer;* Ger., *Eisenchlorid*)

Synonym, protochloride of iron. $FeCl_2 4H_2O$. Molecular weight, 199. Solubilities, 1 in 1·4 water, soluble in alcohol. It is a greenish crystalline salt, rapidly oxidised on exposure to the air into perchloride. It is made by dissolving iron wire in hydrochloric acid. It was suggested as a substitute for ferrous oxalate in the oxalate developer, and was occasionally used in the powder process.

FERROUS CITRO-OXALATE DEVELOPER

A modification of the ferrous oxalate developer suggested by Abney:—

1.—Neutral potassium citrate	9 oz.	450 g.
Neutral potassium oxalate	2½ ,,	112 ,,
Distilled water to	20 ,,	1,000 ,,
2.—Ferrous sulphate.	4 oz.	200 g.
Distilled water to	20 ,,	1,000 ccs.

For use, mix in equal parts. Cowan suggested the following, and it is especially suitable for gelatino-chloride plates, as any warmth of tone may be obtained by variation of exposure and developer:—

1.—For cold tones:		
Neutral potassium oxalate	1,200 grs.	125 g.
Neutral potassium citrate	400 ,,	42 ,,
Distilled water to	20 oz.	1,000 ccs.
2.—For warm tones:		
Citric acid	3,200 grs.	333 g.
Ammonium carbonate	2,400 ,,	250 ,,
Distilled water to	20 oz.	1,000 ccs.
3.—For extra warm tones:		
Citric acid	4,800 grs.	500 g.
Ammonium carbonate	1,600 ,,	166 ,,
Distilled water to	20 oz.	1,000 ccs.
4.—Iron solution:		
Ferrous sulphate	6½ oz.	333 g.
Sulphuric acid	¼ ,,	12·5 ccs.
Distilled water to	20 ,,	1,000 ,,

For use, add 1 part of No. 4 to 3 parts of Nos. 1, 2 or 3.

FERROUS NITRATE (Fr., *Azotate ferreux;* Ger., *Salpetersaures Eisenoxydul*)

Synonym, protonitrate of iron. $Fe(NO_3)_2 18H_2O$. Molecular weight, 536. Solubilities, 1 in 6 water, soluble in dilute alcohol. It occurs as greenish white crystals. It may be prepared by dissolving iron wire in nitric acid, but the usual method is to mix 19 parts of ferrous sulphate with 36 parts of barium nitrate in solution, which gives 26 parts of ferrous nitrate. It was used in the wet collodion days, and gives an image much whiter in colour than does the ferrous sulphate.

FERROUS OXALATE (Fr., *Oxalate ferreux;* Ger., *Eisenoxalat*)

Synonym, oxalate of iron. $FeC_2O_4 2H_2O$. Molecular weight, 180. Practically insoluble in water, but soluble in alkaline oxalate solutions. Prepared by decomposing ferrous sulphate with oxalic acid, but generally obtained by mixing potassium oxalate and ferrous sulphate, in the form of ferrous potassium oxalate.

FERROUS OXALATE DEVELOPER

One of the oldest developers for plates and bromide papers, announced in 1877 simultaneously by Carey Lea and Willis, of America and England respectively, now almost entirely replaced by the newer organic developers. It has the great advantage of giving an image in pure metallic silver—that is, without any oxidised stain which is so often the defect of the newer developers; but, on the other hand, it oxidises rapidly, and gives in hard water a precipitate of oxalate of lime. Also, it raises the inertia of the plate, or, in other words, it does not bring so much out of a plate as do the newer developers. In the case of bromide papers, it is necessary to use an acid bath after development in order to prevent the deposition of basic iron salts in the fibres of the paper; and this disadvantage has led to its disuse. It can be prepared most conveniently by double decomposition between potassium oxalate and ferrous sulphate. The following may be considered a standard formula:—

1.—Neutral potassium oxalate	5 oz.	250 g.
Distilled water to	20 ,,	1,000 ccs.
2.—Ferrous sulphate.	6½ oz.	330 g.
Distilled water to	20 ,,	1,000 ccs.
Pure sulphuric acid	10 mins.	1 cc.

For use, add 1 part of No. 2 to 4 parts of No. 1. The iron must be added to the oxalate, and never vice versa, so that the oxalate is always in excess, because ferrous oxalate is insoluble in water and soluble only in excess of an alkaline oxalate. The developer is a deep orange solution which does not keep well. Another method of making it is by heating the oxalate solution to boiling point and adding dry ferrous oxalate until saturated, and then cooling and bottling;

but the first method is preferable. Bromides can, of course, be used as with any other developer, and the addition of a very small quantity of "hypo," ·06 per cent., acts as an accelerator.

FERROUS OXALATE INTENSIFIER

In this process of intensification the negative, after bleaching in mercuric chloride, is blackened by the application of the ferrous oxalate developer, which reduces the white silver and mercurous chloride image to metallic silver and mercury. The advantage of this process is that any amount of density may be obtained by repeating the bleaching and blackening, each repetition adding more mercury, and, so far as is known, the image thus obtained is quite stable, and there is no selective action either in the high lights or shadows. It is important to wash thoroughly, preferably in water acidified with hydrochloric acid, after bleaching and before blackening. J. Chapman Jones recommends bleaching the well washed negative in a cold saturated solution of mercuric chloride to each ounce of which one or two drops of strong hydrochloric acid have been added. Afterwards, the negative is washed for one hour, blackened with a developer composed of 6 parts, by measure, of a saturated solution of potassium oxalate and 1 part of a saturated solution of ferrous sulphate.

FERROUS POTASSIUM OXALATE (Fr., *Oxalate de potassium ferreux;* Ger., *Kalium-Eisenoxalat*)

Synonym, potassio-ferrous oxalate. $K_2Fe(C_2O_4)_2H_2O$. Molecular weight, 328. Obtained in the ferrous oxalate developer by the admixture of ferrous sulphate and potassium oxalate. If the sodium salt is used, ferrous sodium oxalate results.

FERROUS SODIUM OXALATE (*See* the preceding article.)

FERROUS SULPHATE (Fr., *Sulfate de fer;* Ger., *Schwefelsaures Eisenoxydul*)

Synonyms, sulphate or protosulphate of iron, green copperas, green vitriol. $Fe\,SO_4\,7H_2O$. Molecular weight, 278. Solubilities, 1 in 1·8 cold and ·5 boiling water, insoluble in alcohol. It occurs as large bluish green crystals, efflorescent in air, obtained by treating iron wire with dilute sulphuric acid. It is used as the developer for wet collodion plates and to prepare the ferrous oxalate developer. On exposure to air it becomes oxidised and covered with a rusty powder of basic sulphate, which should be rinsed off before the crystals are dissolved.

FERROUS SULPHATE DEVELOPER

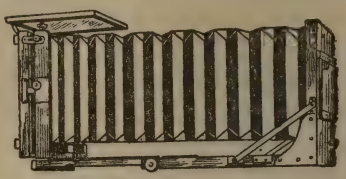
A developer used for wet collodion plates, of which the following may be considered a typical formula :—

Ferrous sulphate	. 350 grs.	40 g.
Glacial acetic acid	. 310 mins.	30 ccs.
Alcohol . .	. 310 „	30 „
Distilled water to	. 20 oz.	1,000 „

A great many additions have been recommended, such as copper or magnesium sulphate, sugar, glycerine, albumen, etc., all of which are supposed to have some special advantage. The development of a wet plate differs from that of a dry, in that it is what is termed "physical development"; that is to say, the latent image itself is not developed, but the silver nitrate adherent to the film is reduced by the ferrous sulphate and deposited *in situ* on the latent image, so that the growth of the image is from the top and not from the bottom or in the film, as with the chemical development of a dry plate.

FIELD CAMERA (Fr., *Chambre de touriste, Chambre de voyage, Chambre portative;* Ger., *Reisekamera, Landschafts-kamera*)

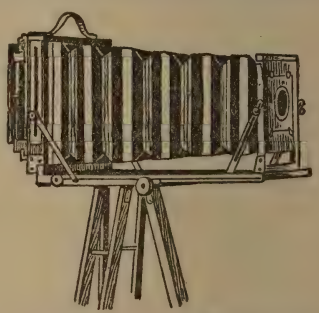
Field cameras are necessarily designed to obtain the maximum of compactness and the minimum of weight consistent with steadiness.



A. Square-bellows Field Camera

Since they will be more exposed to atmospheric and climatic influences than indoor cameras, the workmanship must be good, and the wood of excellent quality and well seasoned. Rigidity is of great importance. When extended, there should be no shake or looseness at either front or back if grasped firmly with the two hands. The choice of pattern depends somewhat on the nature of the work to be undertaken.

For technical, engineering, and suchlike purposes, a square bellows camera of somewhat heavy construction is usually preferred. Illustration A shows an apparatus which can be used in the studio or on a tripod outdoors. The rigid front is suited for carrying heavy lenses, while the bellows racks backwards from the front, a useful movement in wide-angle work, where part of the image is sometimes liable to be cut off by the projecting baseboard of the

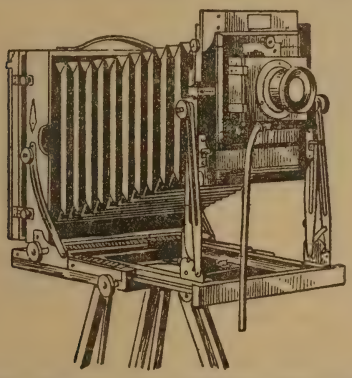


B. Tapering-bellows Field Camera

ordinary type of camera. The back focusing movement is also valuable in photographing small objects at close quarters. The baseboard folds over the focusing screen when closed, thus preventing it from getting broken.

A lighter, yet still substantial, type of camera, suitable for general work out of doors, is illustrated at B. The swing front is useful when

photographing high buildings, and a sufficient amount of rise is also provided for. The back, which can be swung either horizontally or vertically, is arranged to slide close up to the front if desired, for use with wide-angle lenses. A well-known camera, noted for its great range of movement and particularly adapted for archi-

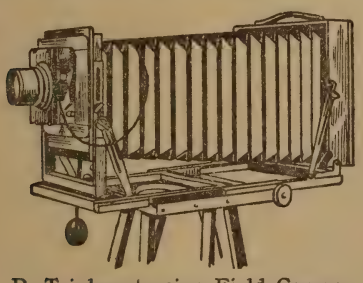


C. Field Camera with Extreme Rise of Front

tectural photography, is shown at C. The back and front may be swung in every imaginable position with ease, and at once rigidly clamped or locked. The extreme high rise of front will be noticed. The front not only rises and falls by rack and pinion, but may be moved horizontally or diagonally by means of a compound sliding and revolving device.

A representative example of a moderate priced triple-extension camera is illustrated at D. A triple extension allows the bellows to be racked out to about three times the focal length of the average lens used with a camera of a given size, and is an invaluable feature when using long-focus lenses.

The cameras above mentioned are illustrative of the chief tendencies of design in modern field apparatus. A notable advance is shown on earlier ideals of construction, especially with regard to lightness, compactness, and the provision of mechanical conveniences. Double



D. Triple-extension Field Camera

book-form dark slides are usually preferred with field cameras, and they should work without either stiffness or looseness. (*See also* "Camera," "Dark-slide," etc.)

FIELD, DEPTH OF (*See* "Depth of Definition, etc.")

FIELD LENS

The lower lens of a microscope eyepiece that receives the image from the objective, as explained under the heading "Eyepiece."

FIELD OF LENS

The imaginary surface at which the sharpest image that can be given is formed. With a theoretically perfect lens, this would be a plane, but in practice the field is usually concave, occasionally convex, and in the case of most anastigmats, plane with an annular depression at a considerable distance from the centre. In the theoretically perfect field all the rays, axial and marginal, come to a focus on a plane which is at right angles to the axis of the lens. This condition is fulfilled by one or two of the modern anastigmats, especially those made for copying. The most ordinary type of field is concave, the concavity being away from the lens. Before the introduction of the special Jena glasses, this was considered normal, in fact, inevitable, for so eminent an optician as the late J. H. Dallmeyer stated that a lens having a perfectly flat field "does not exist, and cannot be made." The amount of curvature of field varies greatly in different types of lenses, being most pronounced in portrait lenses of large aperture, less in single landscape lenses, and least of all in well-constructed rapid rectilinears. Other things being equal, it will be found that separating the elements of a double combination lens has a tendency to flatten the field, at the risk of increasing the astigmatism present; while in the case of single lenses the curvature is reduced to a minimum by placing the diaphragm as far as practicable from the lens. The field of a typical anastigmat is flat in the centre for a considerable distance from the axis, then comes a "dip" and then a recovery to almost the original plane. A field that is convex towards the lens is rarely found in practice, generally occurring in modern anastigmats which have been slightly over-corrected for flatness in the endeavour to attain other qualities.

FIGURE STUDIES

Portraiture is mainly directed to securing a "likeness," while figure studies are generally intended to show character, costume, occupation, and so on. Renderings of figures in homely surroundings, or engaged in somewhat humble everyday occupations, are generally classed as "genre." The great thing to avoid in successful figure work is any suggestion of posing or of camera-consciousness. Sometimes figures are dealt with as what may be called character studies, in which case care must be taken that position, lighting, view-point, and general treatment are all directed to securing the particular characterisation desired. In other cases the figures, singly or collectively, are treated in "settings," or surroundings suggestive of their habits and employments. Whatever their occupation, work, or play, they should appear natural, and not suggestive of merely performing for the occasion. This does not imply that a certain amount of posing and arrangement must not be resorted to, but that there should be no evidence of such.

In the case of character studies, careful observ-

ation of the subject is necessary to realise precisely what is to be rendered in each particular case. Study is also equally essential where occupation is to be suggested. There are certain poses and movements that are more effective and suggestive than others, and these must be watched for and noted. The sweeping movements of a mower, for example, cannot be shown completely, but the "arrested motion" should be suggestive of action and not of a stationary pose. A blacksmith with his hammer poised in the air is more suggestive of energy and force than if his hammer is resting on the hot iron. In every such case the most characteristic position must be diligently sought for. The human interest always makes figure studies attractive, but it is extremely difficult to secure unqualified success without careful observation and continued practice and experience. It is, in fact, a branch of photographic work that demands special aptitude, but one that well repays the utmost care that can be devoted to it.

FIGURES IN LANDSCAPES

There are some landscape subjects that appear quite complete without figures of any kind; in fact, in some cases, the introduction of the smallest figure would be detrimental. Frequently, however, a landscape without figures gives the impression of a mere setting—an empty stage. It has been said that in a perfectly composed landscape there is one, and only one, correct position for a figure or figures. It is, in fact, an exceedingly difficult matter to introduce figures into a landscape with complete success. They must be neither too prominent so that they attract undue attention, nor too insignificant so that they fail to take their place in the composition. Above all, the figures must be appropriate to their surroundings; they must not only be in the picture, but of it.

The relation which figures bear to the landscape varies. They may be so unobtrusive as merely to convey a necessary suggestion of life, or they may be so prominent as to claim more attention than the actual landscape. In the latter case, they are rather figures with landscape, although the landscape is an important integral part of the whole picture. When several figures are included they should not be scattered indiscriminately, but should bear some relation to each other as well as to their surroundings. To this end it is helpful to study the character, placing, and arrangement of figures in landscapes by good artists, and also carefully to examine photographic examples in which figures have been satisfactorily introduced.

FILIGRANE

A photographic process for water-marking paper, invented by W. B. Woodbury. A gelatine relief of the design is made by the Woodbury-type process, and when thoroughly hard and dry is passed through a rolling press with the paper to be water-marked. The result is that the paper is pressed thinner in some parts than in others, the thin parts appearing much lighter. On holding the paper up to the light a water-marked image is seen. The relief can be used a large number of times.

FILM (Fr., *Pellicule;* Ger., *Film*)

This term is applied to the surface which carries the sensitive silver salt: thus the film side of a paper or plate (Fr., *Pellicule;* Ger., *Schicht*); but it has also become very generally applied to distinguish any flexible support from glass plates. The subject of flexible supports can for historical purposes be most readily dealt with by dividing it into the following classes: (1) negative paper; (2) stripping films; (3) cut films; (4) roll films.

Negative paper was, of course, one of the first forms of negative material, and was introduced by Fox Talbot, in 1839, who also suggested making the finished negative more translucent by waxing it. Le Gray, in 1854, introduced the wax paper process, in which the paper was waxed prior to sensitising. In 1849, Fox Talbot and Malone took out a patent for a resin-coated paper which was used by Newton in 1850, Le Gray in 1852, and Tillard in 1854. Crawford in 1854 used collodion-coated paper, and Geoffray in 1856 impregnated paper with rubber solution, fastened it to a glass plate coated with glycerine, coated it with collodion, and afterwards stripped it. Corbin in 1858 used collodionised paper; and Marion in 1863 also used dry collodion paper. Laoureux in 1878 used a wax paper, which was rubbed with French chalk, coated with collodion according to the bath process, and the fixed negative was squeegeed down to a sheet of gelatinised glass whilst still damp, allowed to dry, and then stripped from the glass. In 1879, Ferrier, of Paris, patented a film of collodion and gelatine, and in the same year Stebbing introduced gelatino-bromide films on a hardened gelatine skin. Palmer, of Liverpool, in 1881 produced a film of gelatine and oxgall. In 1882 Morgan, of Morgan and Kidd, introduced negative paper, and Warnerke in 1884 made paper coated on both sides with emulsion, so as to avoid the curling of the paper and negatives. In 1885 Woodbury and Vergara utilised a paper made transparent with resins, etc.; and ordinary negative paper was produced by Wilde, of Görlitz. Eastman in 1885, Moh in 1898, Lumière, the Thornton Film Co., in 1900 (paperoid films), and Gaedicke in 1889, used thin varnished tracing paper.

Stripping films were made by Milmson in 1877, Ferran and Pauli in 1880, Thiebault in 1886, Wilde in 1887, Moh in 1898, Balagny in 1898, Hofmann in 1901, Goldbacher in 1901, the Thornton Film Co. in 1901, and Wellington in 1901. In all these the paper was prepared either with a soluble gelatine film, or wax, rubber, or resin, which allowed the finished negative to be stripped from the paper support.

Cut celluloid films were first suggested by Fourtier (France) in 1881, but Carbutt (U.S.A.) seems to have been the first to introduce them commercially in 1888, though he had made some in 1884. In 1882 Pumphrey (Birmingham) introduced a "flexible glass" support, consisting of gelatine and collodion, and Moh in 1890, and Raphael in 1892, used thin sheets of mica. Froedman in 1887 introduced a support of bichromated gelatine which had been rendered insoluble by exposure to light; Stebbing in

1879 used a hardened gelatine film between two films of collodion; and Wilde in 1883 used insoluble gelatine and collodion. Balagny in 1886 used alternate layers of collodion, varnish, and gelatine. In recent years most plate makers have produced cut celluloid films one-hundredth of an inch in thickness.

Roll films seem to have been first suggested by Melhuish and Spencer in 1854, and by Merritt and Warnerke in England and Captain Barr in India in 1875. Barr was the first to suggest the present system of using a black material at the back of the film, which was continued beyond the ends of the sensitive material (then paper) to protect it from light. Roll celluloid films appear to have been conceived first by Goodwin (U.S.A.) in 1887, although the patent was not granted till 1898; while this patent was lying in the American patent office, Reichenbach, of the Eastman Kodak Co., applied for a similar patent, which, like Goodwin's, included the "non-curling" layer of gelatine on the back of the celluloid. Cody, of the Blair Camera Co., patented in 1894 the use of the now well-known daylight loading cartridge. Many of the manufacturers who are mentioned as making cut stripping films also prepared roll films, but the celluloid, about $\frac{3}{1000}$ in. thick, is now almost universally used.

The treatment of films, as regards development and fixing, is precisely the same as for plates. The only point to which attention should be directed is the keeping power of the emulsion when this is coated on celluloid, and though this is generally recognised to be practically limited to twelve months after coating, instances have been recorded of films—especially cut films—being fit for use after five years. This possibly can be explained by the different state of dryness of the support.

In process work, the word "film" is applied in several ways. There is the film obtained by stripping negatives. The "Lotus" film was introduced by Mawson and Swan to facilitate the obtaining, by stripping, of film negatives, these films being of hardened gelatine of substantial thickness.

The gelatine films known as "Shading Mediums," often simply called "films," have lines, stipples, or patterns moulded on their surface, so that they can be inked and the pattern transferred by rubbing down with a stylus, or by pressure with a small rubber roller.

The "Norwich Film" is a transparent gelatine film grained on one side for drawing upon in pencil, crayon, or ink, according to the degree of fineness or coarseness of the grain. By making the drawing with a greasy ink the surface can afterwards be flowed over with a non-actinic alcohol soluble varnish, which will not affect the drawing. The latter can then be washed away with turpentine, leaving the lines or granulations transparent, so that the film becomes a negative which can be printed from by any photographic process. If the film is drawn on with lithographic crayon or lithographic transfer ink, the drawing may be transferred in the usual lithographic manner by damping the gelatine and running through a press in contact with stone or zinc.

FILM CAMERA (Fr., *Chambre à pellicule;* Ger., *Filmkamera*)

In its primary sense, a camera specially designed for use with films, whether flat or in the roll. Such cameras are mostly of the hand type, and typical examples of the various kinds will be found under the heading "Hand Camera." Any ordinary camera may, however, be used with films by the simple expedient of employing a roll-holder instead of a dark-slide; or, if flat films are preferred, a suitable changing box, adapter, or film pack may be used.

FILM CARRIER (Fr., *Porte-pellicule;* Ger., *Filmrahmen*)

A kind of sheath, usually of thin metal turned over at the edges on three sides, used for holding flat films in dark-slides or in hand cameras. Some carriers are indented from the back so that the film is kept close to the front, in order to be in register with the focusing screen; others require the insertion of a piece of black cardboard between the film and the carrier. Another type of carrier consists of a flat metal back over which folds a hinged frame. The film is laid on the back and the frame closed down on it, securing itself by a clip at the edge.

The term film carrier is also sometimes applied to roll-holders and adapters for holding films.

FILM HARDENERS (*See* "Hardeners.")

FILM HOLDER (Fr., *Pince à pellicule;* Ger., *Filmshalter*)

A metal or wooden clip used to hold the ends of roll films when developing in the length. Another kind consists of a flat piece of metal turned over at two edges, to hold a short portion of film, cut from the length, flat during developing. The term film holder is also sometimes given to the roller slide, or roll-holder (*which see*).

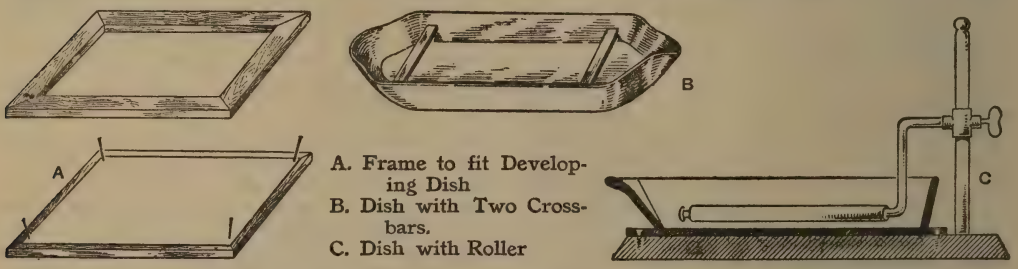
FILM MANIPULATION

The use of films, both flat and rollable, has become during recent years more and more popular, and there has been much discussion as to whether these or plates are the more advantageous, although, results alone considered, there is no difference between them. The developers, fixers, intensifiers, etc., suitable for dry plates will suit films also, for the reason that the emulsions are the same although the support is glass in the first case and celluloid in the second.

Flat Films.—Flat films are treated exactly as though they were plates. There may be difficulty in keeping them wholly immersed in the solutions, on account of their buoyancy, which tends to make them float on the surface of the liquid, thus leading to uneven development, markings, and yellow stains. It is best first to place the required amount of developer in a dish and to slip the film face upwards into it well under the surface; or the film may be placed in a dry dish and the developer poured on. By rocking the dish the film is kept on the move, and the developer made to flow evenly over it. Some workers use a narrow wooden frame A, which tightly fits the bottom of the dish; the film is then pinned face upwards to

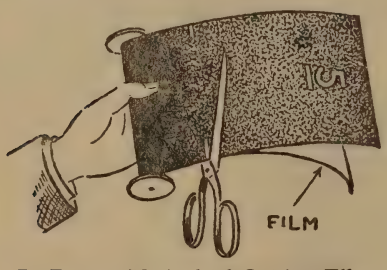
the frame and the developer poured on. But this method ought not to be necessary except that films tend to curl very much when wetted. The disadvantage of using a false bottom entirely of wood is that unless it fits very tightly in the bottom of the dish it may float on the surface and do more harm than good.

Cutting Roll Films.—Only when roll films are unrolled in a proper way is there little or no danger of cutting through the images. The cutting up of a roll film before development is necessary only when each exposure is to be developed separately, after the manner of flat films. D shows the proper and E the improper method of cutting up a roll film. The roll should be held in the left hand and the end of the wound-up film pulled with the right, the black paper being on the top and the film beneath. Only one number should be unwound at a time, and when the division marks at the edges are seen (between the numbers), the film is placed in contact with the black covering paper and both cut through evenly with a pair of scissors; by this method the paper and film are in contact and in agreement as in the camera. The wrong way of cutting up a film (*see* E) is to bring the loose white film to the top of the black paper, because when this is done the images will invariably be cut through, as the division markings will not be true. The film must be swung round below the paper, in the direction shown by the dotted lines.

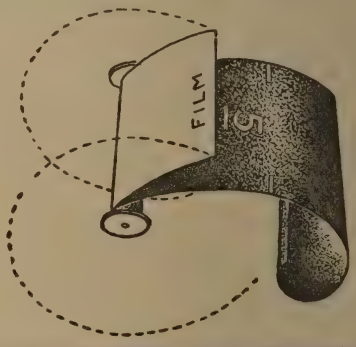


A. Frame to fit Developing Dish
B. Dish with Two Cross-bars.
C. Dish with Roller

Developing Roll Films.—The object of cutting up films is to avoid the awkward operation of developing them in the strip form. With the shorter lengths there is, however, no difficulty in developing them whole, but when longer than 36 in. it is better to cut them up or to use one of the numerous film-developing devices on the market, which, of course, are suitable for the shorter lengths also. At B is shown a dish having two cross-bars, under which the film is threaded, the whole length of film being worked backwards and forwards through the developer, which should cover the bars. In a contrivance, C, embodying the same principle, a bent rod carries a roller acting as a bar to keep the film under the developer; with both these contrivances it is necessary to hold one end of the strip in each hand after the manner shown at F. A contrivance on a different principle is shown at G; one end of the film is attached to a spring drum, which is made to revolve, and the film passed through the developer by alternately pulling and slackening the other end. These and other accessories are very convenient, but in their absence the following method may be adopted. A dish is filled with the developer. The whole length of film is detached from the black paper, one end is taken in each hand, and the film is passed, sensitive (matt) side downwards, through the developer, a see-saw movement of the arms being maintained, and the film passed to and fro through the developer until the whole series of images is fully developed. It is a good practice to develop the whole strip until the barest outlines are visible, and the spaces dividing the pictures can be distinctly seen; the film can then be cut with scissors, the partly developed pictures placed in cold water, and each one developed separately in an ordinary flat dish. It is advisable to keep the partially developed films on the move while in the water, as, if allowed to stand, they may remain curled up or on the surface, in which case markings and stains would appear.



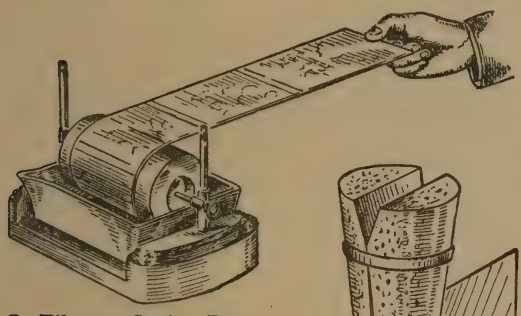
D. Proper Method of Cutting Film



E. Incorrect Method of Cutting Film

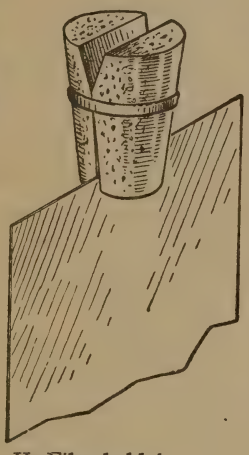
Fixing.—Films may be fixed in the strip, or cut up. Even if the film is developed in strip form, it may be advisable to cut it up before or during fixing, for the sake of convenient handling; but

opinions differ on this point. Films need more care than plates when fixing, because, should the films float on the surface of the fixer, exposure to the air will cause markings, yellow stains, etc., which cannot easily be removed. An acid fixing



G. Film on Spring Drum

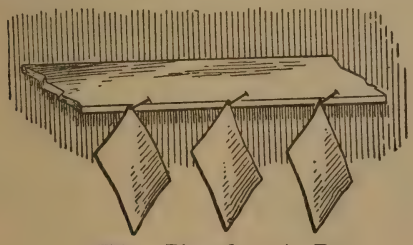
F. Developing Film



H. Film held in Cork Clip

bath (potassium metabisulphite and "hypo") is better than an ordinary fixing bath of plain "hypo," as the metabisulphite prevents stains.

Washing and Drying.—Films cannot be washed and dried in a rack like plates, and some trouble is often met with in keeping them under the surface of the water. Numerous devices have been introduced for washing films properly. A useful contrivance is shown at H; a cork is cut in halves lengthways, after cutting a notch in the top; then an indiarubber band is placed around the halves as shown, the whole now forming a clip. The film is inserted in the cork, which will float on the surface of the water and



I. Films Pinned up to Dry

hold the film beneath the surface. Films are best dried by pinning them, face (emulsion surface) outwards, to a shelf, as shown at I, or special clips may be used in place of pins. All flat films should be kept under slight pressure when not in use. If a film is stored in a roll, it should always be wound sensitive surface outside, as it will then lie flatter when printing. Films are better varnished, and for wet films a borax and gum lac solution is best, but for dry films a dammar varnish may be used. (*See* "Varnishes.") By the aid of special tanks, the development of films may be carried out in daylight.

FILM PACK

A device for exposing a number of cut films successively. A holder, somewhat similar to a dark-slide, is loaded with a packet of cut films. This can be done in daylight. Projecting from the packet are paper tabs, and by pulling these out and tearing them off the films are successively brought into position for exposing, and then carried round to the back of the pack. When all the films have been exposed, the pack may be removed from the holder (still in daylight), and a fresh one substituted. This provides a convenient means of exposing an indefinite number of cut films without having to resort to a darkroom. Some cameras are made for using a film pack only, in which case the holder is usually an integral part of the camera; but the holder or adapter is also suitable for use on other cameras interchangeably with dark slides. A special tank has been devised for the development of cut films as used in the pack, although, of course, its use is a convenience rather than a necessity.

FILM SHEATH (Fr., *Étui à pellicule, Porte-pellicule;* Ger., *Filmscheide, Filmrahmen, Blechrahmen*)

A metal sheath for holding flat films in magazine hand cameras; practically identical with certain forms of film carrier (*which see*). Ordinary plate sheaths may be used for films if a piece of black cardboard is inserted behind each film. In some patterns of hand cameras, the changing mechanism is designed for use with sheaths of a definite thickness, and will not work with thinner sheaths.

FILM STRIPPING

Films may easily be stripped from their glass supports and transferred as required, this course often being necessary when the glass of a negative is cracked and the film is undamaged. In reversing a negative for single transfer carbon or collotype work, the stripping method is also useful. If desired the film may be enlarged in course of transference, as described under the heading "Enlarging by Stripping." In cases where it is not desired to enlarge the film, the hydrofluoric acid used for stripping must be diluted with methylated spirit, which, to some extent, counteracts the tendency to expand. The following is suitable:—

Methylated spirit .	5 oz.	1,000 ccs.
Water . .	1½ drms.	37·5 ,,
Glycerine . .	1½ ,,	37·5 ,,
Hydrofluoric acid	1—1½ ,,	25—37·5 ,,

Make this up without the acid and keep as a stock solution, adding the acid just before using. The negative to be stripped should not have been varnished, or, if it has been, the varnish must be removed before treatment. It should be noted that hydrofluoric acid attacks

glass, and any mixture containing the acid must therefore be kept in an indiarubber or ebonite cup or dish, or in a glass vessel that has been coated internally with paraffin wax (the wax is melted, poured in and out again, leaving a coating on the sides). Some sheets of waxed paper are also needed before the work of stripping can be begun, also a glass plate coated with gum or gelatine on to which the film is to be transferred, for owing to the use of a large proportion of spirit the removed film will not adhere to plain glass. Lay the negative to be stripped on a perfectly level surface, and with the aid of a straightedge, and by means of a sharp penknife, cut through the film to the glass at ¼ in. from the edge all round; then pour enough of the stripping mixture on to the film and spread over evenly with a camel-hair brush, or a piece of paper or cotton-wool. In about five minutes the film will become loose, and the narrow bands of film at the edges may be stripped away, this being a good test as to how the stripping mixture is working on the film. If after five minutes the film refuses to move, a little more acid may be added to some more of the solution, and spread over the film. No attempt must be made to hasten the loosening of the film at the edges by pulling; the acid must do all the work. When the margin comes away without the slightest resistance, it is a sign that the main film is in a state to be removed. A penknife may be inserted under one corner of the film just to see if this will come away easily from the glass. The film being still on the plate, drain off superfluous acid, and pour on more of the stripping mixture, this time without the acid. This in turn is poured off, and a sheet of the waxed paper brought down upon the loosened film, and lightly squeegeed down. The film will adhere perfectly to the waxed paper, and they can be removed together on to the new glass and squeegeed over lightly; the paper is then pulled gently away, leaving the film upon the prepared glass.

When a reversal—as regards right and left—is wanted, the film on the original negative should be transferred to a plain piece of white paper covered with the spirit mixture minus the acid; the waxed paper is then laid over the removed film, and the two papers, with the film in between, squeegeed into contact; the papers are then separated carefully, in such a manner that the loose film remains on the waxed paper; it is then transferred to the prepared plate in the manner described above, care being taken to keep the film flat and in perfect contact with its support.

Owing to objections to the use of hydrofluoric acid, many prefer to do without it, and they employ some such method as the following. The film is liable to slight enlargement, by about one-thirtieth of its length, which matters little if it has been cut round the edges in the manner already described. The negative is placed in the following bath:—

Caustic soda . .	20 grs.	23 g.
Formaline . .	20 drops	21 ccs.
Water . . .	2 oz.	1,000 ,,

The formaline toughens the film, and in about ten minutes the film could, if it were desired, be rolled back with the finger. But do not do so; instead, when it appears to be loose, transfer to the following bath:—

Glycerine . .	60—70 drops	63—73 ccs.
Hydrochloric acid .	50 ,,	52 ,,
Water . . .	2 oz.	1,000 ,,

in which it can be entirely detached, and as it floats in the liquid either side may be attached to the new glass. In order to ensure the film sticking to its new support, it is advisable that the following substratum should be applied to the glass:—

Formaline . .	10 drops	1 cc.
Gelatine . . .	4 grs.	4·5 g.
Water . . .	2 oz.	1,000 ccs.

Swell the gelatine in the water, dissolve by heating, and add the formaline; coat the glass, allow to dry, transfer the wet film to it, press down, and allow to dry naturally. A fixed and washed unexposed dry plate also serves as a support.

Films are removed from celluloid supports by soaking in the caustic soda and formaline mixture already given, and then in the hydrochloric acid and glycerine bath; the films, slightly enlarged, are washed and transferred to glass or celluloid.

A convenient method of using hydrofluoric acid for stripping is to manufacture it as required, which can be very easily done by making a solution of sodium, ammonium or potassium fluoride, about 10 grs. to the ounce of water (20 g. to 1,000 ccs.), and acidulating with a few drops of some strong acid, such as sulphuric or nitric, applying the mixture to the negative. Hydrofluoric acid is generated and strips the film, and the solution may be thrown away when it has done its work. The dry fluorides keep well in ordinary glass bottles.

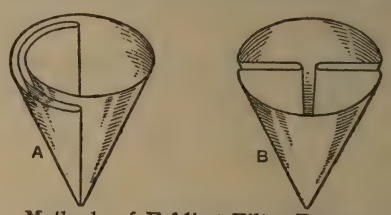
FILMOGRAPH (Fr., *Filmographe;* Ger., *Filmograph*)

The name given to an early pattern of film camera by Humphrey.

FILTER (*See* "Colour Screen or Filter.")

FILTER PAPER (Fr., *Papier à filtrer;* Ger., *Filtrierpapier*)

Paper folded into a funnel for the purpose of filtering liquids. Practically only two kinds of filter paper are known to photographers, the



Methods of Folding Filter Papers

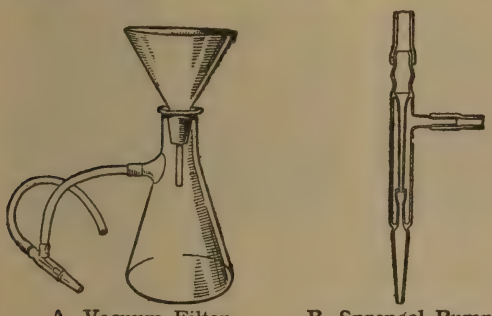
white and the grey, cut in circular form. They are sold in packets of one hundred, the size ranging from about 2½ in. to 20 in., and the prices from about 3d. to 2s. 6d. per packet. There are many ways of folding such papers

into cones for fitting funnels, two of the most general being here illustrated. A shows the commonest style, the paper being first folded into halves and then into quarters; it is then placed in the funnel and one side opened out. In B the circle is first folded into halves and then laid flat again, leaving a crease to show the diameter. The ends of the diameter are then brought together and the halves opened out.

FILTER, VACUUM

A device by means of which liquid is forced through a filtering medium by atmospheric pressure.

A simple form of filter for viscous fluids, such as the fish-glue solution used by process workers, is that shown at A. A strong glass flask of about one litre capacity has a nipple connection blown into its side near the neck. To this nipple a Sprengel "pump" of glass is attached by means of a rubber tube. The construction of the "pump" is shown at B. The inner tube is not continuous, but consists of two tapering tubes,



A. Vacuum Filter B. Sprengel Pump

one being sealed to the upper end of the outer tube and the other to the lower end, their tapered ends meeting and being enclosed one within the other for a short distance. The air drawn from the flask can thus pass between them. The vertical nozzle of the "pump" is connected with a water-tap. The rubber tubes must be tightly bound on, or they will be blown off by the pressure. The funnel containing the filtrate is thrust through a rubber bung placed in the neck of the funnel, and it is desirable to have a perforated porcelain plate in the funnel to prevent the filtering medium, which may be cotton-wool, glass-wool, or felt, being sucked down the neck of the funnel. The filtrate having been poured in, the water-tap is turned on and the rush of water through the "pump" draws the air out of the flask, creating a vacuum in it. Thus the filtrate is powerfully sucked through. It is desirable to have a clip on the tube leading from the flask to the "pump," so that the tube can be pinched when the water is turned off, or the water in the tube will be sucked back and dilute the filtered liquid.

FILTRATION (Fr., *Filtration;* Ger., *Filtrieren*)

A process used to remove from a liquid or solution any insoluble or extraneous matter. Usually an unsized, pure, porous paper is used. (*See* "Filter Paper.") For ordinary purposes a small tuft of absorbent cotton-wool stuffed into the neck of a funnel will usually suffice. For filtering emulsions well-washed swansdown, or a felt filtering bag, may be used. It should be noted that developers should only be filtered—or strained, to use a more correct term—through loosely packed wool, otherwise they may oxidise. Glass-wool (finely spun threads of glass) is used for filtering collodion or corrosive liquids which would attack paper or cotton-wool.

FILTRATION, UPWARD

A method of filtration which it is convenient to adopt in the albumen process. A glass cylinder, open at both ends, has two thicknesses of washed muslin tied over one of the ends. The albumen is placed in a vessel slightly larger in diameter than the cylinder, and the latter is then lowered into the vessel, muslin end downwards. The weight of the cylinder forces the albumen solution to pass upwards through the muslin into the cylinder.

FINDER, VIEW (*See* "View Finder," "Direct Finder," "Iconometer," etc.)

FINGER-PRINT PHOTOGRAPHY (Fr., *Photographie à marque de doigt;* Ger., *Fingerspur Photographie*)

The photography and systematic registration of finger-prints has become of immense importance in the detection of crime. The methods employed may be divided into two classes: (1) those used when the individual whose finger-prints are to be examined or registered is present to give more or less voluntary assistance; and (2) those in which the finger-prints have been involuntarily left behind by their originator. The procedure adopted at New Scotland Yard under the first circumstances is very simple. The best black printers' ink is spread in a thin, even film on flat tin-plate or copper by means of a roller. The finger to be recorded is pressed down lightly and steadily on the film of ink, taking care not to move it sideways at all. After a few seconds the finger is raised and pressed down on a smooth white card or paper, when a sharp, clear impression should result. This is known as a "plain" impression. Another kind is obtained by placing the bulb of the finger on the inked slab, facing to the left, and turning it gently over until it faces to the right. The finger is then pressed gently on the paper, rolling it from left to right as before, thus making what is called a "rolled" impression. With an unwilling subject, trouble may arise from the finger being deliberately moved.

For experimental work, a good substitute for the above method is allow a drop of printing ink to fall on a smooth card or glass, and to spread it out with a finger. Finger-prints on white paper may be photographed on a photo-mechanical plate, giving a short exposure to secure contrast and developing with hydroquinone. Prints from the negatives may be made on gaslight paper. Another and quicker way is to have the inked finger pressed on a clean sheet of glass instead of on paper. Several thicknesses of gummed paper in strips are then stuck on the glass at the sides, and it is placed in a printing frame. In the dark-room, a slow, ordinary

plate, backed, is laid film side downwards on the glass, the gummed strips serving to protect the film from the still wet ink. Having inserted the back and fastened the frame, an exposure of about half a second is given at two feet distance from a fish-tail gas burner. This may be done by turning down the gas to an almost invisible blue point, holding up the frame, and then turning the gas up and off as rapidly as possible. On development with hydroquinone a good sharp negative should be secured. The frame must, of course, be kept still. The prints here shown were obtained from negatives made in this way; A, B, C, and D are finger-prints, E and F being thumb-prints. A and B are from the same finger at different times; the lines will be found to tally, and the mark of a slight cut at X is plainly seen in both.

If, however, the finger-prints have to be searched for patiently and carefully, and are eventually found in awkward places, on unfavourable surfaces, and in all probability faint and nearly invisible, the work becomes much more difficult. When trouble arises owing to any unusual colour of the ground on which the finger-print occurs, an orthochromatic plate must be used in conjunction with a suitable colour filter, to secure contrast, each case being treated, of course, according to its particular requirements.

Finger and Thumb Prints

The majority of involuntary finger-prints are greasy ones. To photograph these, if on a light surface, such as china, enamelled furniture, etc., they should be dusted lightly with dry, finely powdered plumbago or graphite; a flat, broad camel-hair brush is charged with a little of the powder, and, holding this a short distance above the finger-print, the handle is tapped gently with the forefinger of the disengaged hand. Or, instead, the hand holding the brush may be nudged or shaken. The surplus powder is carefully blown away with a small bellows; on no account should the breath be used. Greasy finger-prints on a dark surface—old oak furniture or black ironwork, for instance—may be treated in the same manner, using, however, dry, finely powdered whitelead instead of the plumbago.

Finger-prints in blood on a dark surface should be placed where there is no extraneous light, as in a cellar or dark room, and lit from the front with magnesium ribbon or the electric arc, of course screening the direct rays from the lens of the camera.

Another class of finger-prints which call for great care, since the record is so easily disturbed and lost, are those in dust. If on a dark surface, these are readily photographed with a direct front lighting. When they occur on a window-pane or other colourless glass, a dark background should be placed at the back, a short distance away, and the light should come obliquely from behind. In rare cases semi-invisible finger-prints may sometimes be rendered conspicuous by chemical treatment, if there is any idea of the occupation of their suspected producer. Thus, for example, a tanner fresh from work might reasonably be expected to leave traces of tannin in his finger-prints, which, under favourable conditions, could be rendered black by treatment with a solution of a ferric salt.

It is found that a solution of silver nitrate, of say 6 per cent. strength, will occasionally cause the appearance of an unsuspected finger-print on ordinary paper, or will intensify a semi-invisible one.

FINGER TIPS OR STALLS (Fr., *Doigtiers*; Ger., *Fingerlinge*)

Rubber sheaths, like the tips or fingers of gloves, worn when developing, working in wet collodion, sensitising with bichromate, etc., to protect the fingers from staining and as a safeguard against the entrance of poisonous chemicals into cuts or wounds.

FINISHING PHOTOGRAPHS

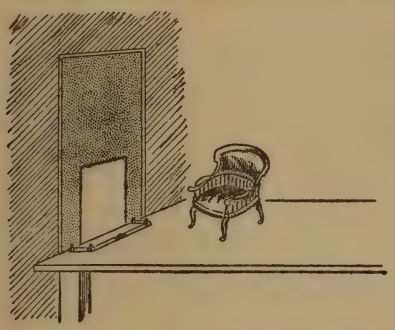
Photographs are frequently finished with crayon or water-colour, and of recent years, the aerograph (*which see*) has been extensively employed for the purpose, this providing an easy means of introducing soft backgrounds. While details of the actual methods will be found under the heading "Working-up Prints," it may be said here that photographs to be finished by hand should be on matt paper, as otherwise the touching-up shows prominently. Ordinarily, the medium (generally water-colour) should match the tone of the print, but for photo-mechanical reproduction this is not necessary. The aim in finishing a photograph should be to strengthen or to modify as may be necessary, and not to introduce work that is not of a photographic character; this naturally forbids all outlining.

In process work, many special considerations have their bearing upon the extent of the

finishing and the methods employed. Much information is given in the article under the heading "Aerograph," and further notes of a practical character will be found at "Working-up Prints."

FIRELIGHT EFFECTS

Effects represented in photographs appearing to have been taken by the fireside and by the light of the fire. Firelight is too weak to illuminate the sitter for photographic purposes without an undue exposure, and artificial aids are necessary. Daylight is the most satisfactory light for the purpose, and the illustration shows the method employed by H. Essenhigh Corke. A suitable window is selected and blocked up with brown paper or other opaque material, leaving, however, a space about 2 ft. square, the bottom of which should be level with the top of a table or platform arranged close to the window. The light admitted by the space is the "firelight," but the space itself does not show in the photograph. A fender and hearthrug may be arranged



Arrangement for Firelight Effects

to make the deception more complete, loose tiles or wallpaper with a tiled pattern being placed in the fender. The sitter should be placed as near to the "fire" as possible, so that the light may be concentrated upon him. A dark background should be used.

Firelight effects may be taken at night by the aid of magnesium. Throwing magnesium powder into a real fire is rarely satisfactory, and a better way is to use a magnesium lamp in an empty fireplace, firing the powder when all is ready for exposure. Any other lights in the room may be left on, as the average artificial light will do no harm. In some cases it will be advisable to use a weak supplementary flash in the room in order to assist the very deep shadows. If there is a good draught up the chimney no magnesium smoke will escape into the room and show in the picture, but if the draught is poor it will be well to fit a sheet of plain glass in the fireplace, in such a way as to trap the smoke. The finished print should be stained with an aniline dye of a suitable tint, so as to give it a firelight colour, and various experiments in toning may be tried.

FIRES, PHOTOGRAPHING

The domestic fire is an awkward thing to photograph satisfactorily, owing to the moving smoke and the non-actinic colour of the red-hot coals. The best effects are obtained by allowing the fire to burn as bright and as smokeless as possible, and then scattering a little saltpetre on it.

The photographing of conflagrations is, in daytime, no more difficult than ordinary landscape or architectural work, the only precaution necessary being, in addition to getting out of the way of firemen and water, to take up, if possible, a position on the windward side, in order that the smoke blows away from the camera and appears more or less as background. Large fires at night generally give out sufficient light to allow of brief exposures.

FIREWORKS, PHOTOGRAPHING

Fireworks really photograph themselves when once the camera is ready. A stand camera must be used, or a hand camera fixed upon some suitable support, as it is impossible to hold a camera in the hand still enough for the necessary exposure. The camera must be focused for what is known as "infinity"; this is best done in daylight by focusing some distant object and fixing the camera at that focus or making a mark on the baseboard, so that the lens may be put in position at night when there is little or nothing to focus. When the firework display begins, the camera is set up in the required position, and the first few rockets looked at on the focusing screen in order properly to judge the correct position. The plate is then inserted and a time exposure given—a minute or more, as desired, or until a sufficient number of discharges has been obtained on the plate. Only one or two fireworks on a plate would look very mean, and it is better to get a good number of discharges, not interfering to any extent with one another. As large a stop should be used as possible, and a rapid plate, backed so as to prevent halation, although with small stops and slow plates some of the very bright rockets may be obtained. The curves taken by rockets in their ascent are very graceful, and care should be taken to get far enough away to include them when they are high and burst. The plates are developed as usual, care being taken not to under-develop, but to secure as much contrast as possible. Firework exposures frequently appear disappointing when in the developer, and the plate may seem to be slow in developing and to lack density, but such exposures generally fix out well. Printing should be deep, so as to get a black background.

FISH, PHOTOGRAPHING

This is a branch of Nature photography offering a field of peculiarly interesting work. The most important part of the outfit is a good stand camera, with a modern anastigmat, working at *f*/6. Isochromatic plates should always be used, where possible, in conjunction with a compensating filter (isochromatic screen). The size of the aquarium or tank, in which the fish are to be placed for photographing, must necessarily be governed by the predominant size of the subjects. It is a great mistake to have too large a tank, for it will cause needless labour and trouble, but at the same time it must be kept in mind that unless the fish has ample room to move freely, it will become alarmed, and will certainly

assume unnatural positions, while in its struggles to escape from its cramped surroundings it may injure itself. The photographic tank should have all four sides of glass, so as to admit as much light as possible, and one of the long sides must be of good "patent plate" glass free from scratches, air-bells, and other blemishes, which would show in the photograph, as it is through this side that the photographs will be taken. This tank should be kept purely for photographic purposes, and not used as a regular stock aquarium, and must be kept perfectly clean inside and out. Cleanliness is most important. The water with which the photographic tank is filled should first be strained through a piece of linen, so that there are no floating particles. The fine shingle used for the floor must be well washed before being placed in the tank, to rid it of mud and fine sand. The plants must for the same reason be well washed; their roots may be cut away, and the base of the stems weighted with a strip of soft lead folded round and embedded in the shingle. It is as well to place the plants rather towards the back of the tank, as otherwise they are apt to get in the way and partially obscure the subject to be photographed. The subject itself will generally be found to look all the brighter and better for a gentle sponging to clean off any dirt that has deposited in the natural slimy secretion with which the body may be coated. The photographic tank should be placed in such a position that as good top and side lighting as possible are obtained. The camera should be placed directly in front of and at the centre of the long side of the tank that is fitted with the "patent plate." This glass must be perfectly clean and free from smears. It is a good plan to keep a soft washleather specially for the purpose. Instead of introducing plants into the photographic tank, a plain tinted background may often be used with advantage. If plants are used, care must be taken to select only those which would be found growing in the favourite haunt of the particular fish to be photographed, otherwise a most unnatural effect will be produced. Fanciful or elaborate backgrounds should never be employed, as they only serve to distract the attention from the fish, and produce a very artificial effect.

Before attempting to photograph a fish, it should be kept under observation for some time in a roomy, well-oxygenated aquarium, so that its habits and characteristic positions may be studied and noted down. When first placed in the photographic tank, the fish will probably dash wildly about, sink to the bottom, and skulk away into the corners. It is no use attempting to begin photographic operations until the fish has got over the fright of being transferred from the stock aquarium to the photographic aquarium, and has become somewhat accustomed to the strong light illuminating the latter. F. M-D.

FISH-EYE CAMERA (Fr., *Chambre à œil de poisson;* Ger., *Fischenauge-kamera*)

J. Alan Stewart, M.A., has published a method of obtaining photographs resembling the views that would be seen by the eye of a fish. Objects against the light of the sky are only perceived by the fish when they fall within the limits of a right-angled cone, whose apex is at the fish's eye, while the base is a circle on the surface of the water, of a little larger radius than the depth of the fish. To produce a photographic imitation of these conditions, a box having a pinhole instead of a lens was employed. Although light-tight except to rays entering by the pinhole, the box was not watertight, but admitted water freely. The sensitive plate was placed 5 in. from the pinhole and the camera was immersed in a larger box filled with water, the exposure being then made on an object—a phantom minnow, for example—3 or 4 in. below the surface of the water in the exterior vessel. An isochromatic plate was used, satisfactory results being obtained with five minutes' exposure in bright sunlight.

R. W. Wood advises the following procedure: A small pail is taken, and into this, rather over half-way up, is fitted a metal disc having a perforated pinhole. The photographic plate is laid at the bottom of the pail in the dark-room, and the pail is filled with clean water, both above and below the metal disc. The pail, which is now practically a camera, is stood on the ground and covered with a sheet of glass, which must touch the surface of the water, so that air does not come between—this preventing ripples. Very interesting vertical pictures may be made with the apparatus. To work horizontally (in the manner in which a fish would observe things through the sides of an aquarium), a watertight box is made, with an opening in one end. A piece of looking-glass is then taken, and a pinhole is made in the film of amalgam on the back, the glass being then cemented over the opening in the box with the unsilvered side outward. In the dark room, a plate is inserted, the box filled with water and the cover replaced. A little more water is added, through a small hole provided for the purpose, in order to displace any air that is present. Some remarkable results are obtained with this camera, which will photograph objects close to the tripod, besides those nearly due right and left, and directly overhead. Naturally, there is a certain amount of distortion, especially at the margins of the view.

FISH-GLUE (Fr., *Colle de poisson;* Ger., *Fischleim*)

The product obtained by boiling fish-skins and other waste remaining from fish-curing, and manufactured principally at Gloucester, Mass., U.S.A. The glue thus procured is permanently liquid, and in a more or less viscous form. It is largely used by photo-engravers for the enamel, enameline, or fish-glue process, but for this purpose it is clarified by boiling with albumen. The glue is preserved with oil of wintergreen.

FISH-GLUE PROCESS

This is described under the heading of "Enameline," by which name it was originally introduced as a secret process.

FITCH-HAIR BRUSH

A brush made from the hair of the polecat.

FIXED-FOCUS CAMERA

A camera in which the relative positions of lens and plate or film are fixed. Such cameras

are usually of a cheap class, although some of the smaller ones are fitted with lenses of high quality. The advantages of a fixed-focus camera are mainly simplicity and readiness for work at a moment's notice. These cameras are frequently fitted with supplementary lenses, or magnifiers, which permit of near objects being focused at fixed distances, usually 3, 6, 9 and 12 ft.

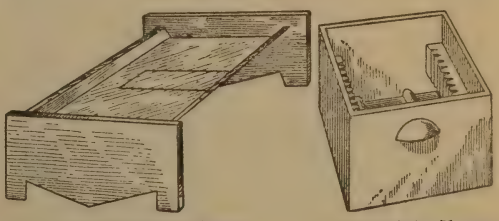
FIXED WHITE (*See* "Barium Sulphate.")

FIXING

The term "fixing" is a misnomer, as, instead of making permanent something that is desired, it removes something that is not desired, and which, if left in the negative or print, would seriously impair it. Fixing, in photography, means the removal of any sensitive salt unacted upon by light, or by the developer, thus rendering the negative or print unalterable by the further action of light. The quantity of silver reduced (developed) in a negative bears a very small proportion to that originally in the plate —very small both in film depth and surface measurement, only the highest lights going all the way through the film, while in the shadows and darker parts little more than the surface is touched. Thus in the average developed film there remains a large proportion—estimated at 75 per cent.—of unaffected silver bromide which must be removed before the negative can be examined with safety in daylight, or be used for printing.

Several substances possess the property of dissolving this unreduced silver. Sodium hyposulphite has the greatest solvent action except ammonia, which for many reasons it is not advisable to use. Although many solvents of silver are known, ammonia, potassium cyanide, and sodium hyposulphite (better known as "hypo") are the most notable. Ammonia, however, is not practicable, because to remove the superfluous silver quickly a very strong solution must be used, and such a solution seriously damages a gelatine film. Potassium cyanide, though used as a fixer for wet plate and ferrotype work, is too expensive for modern dry plates and papers, and in addition is undesirable because of its exceedingly poisonous nature and its liability to eat into the half-tones. The colour of the negative after fixing with cyanide is by reflected light whiter than when "hypo" is used, but by transmitted light, as when printing, it is browner and consequently more actinic. All things considered, however, it is not so good as "hypo." It was in the year 1819 that Sir John Herschel discovered in sodium hyposulphite a solvent for unreduced silver, but the first use of it is credited to J. B. Reade, who in 1837 made the first fixed silver prints from paper negatives. "Hypo" was at that time a very rare salt, and expensive, costing about half a crown an ounce; in 1845 it dropped to 6d. per ounce, in 1857 to 6d. per pound, since when it has become very cheap indeed.

The usual procedure in fixing negatives is to place them film upwards in a flat dish filled with the "hypo" solution, but while such a method serves very well, particularly when the solution is frequently agitated, the work is performed more quickly and efficiently if the plates are held vertically in the solution, which should be in porcelain tanks (as B), or lead-lined zinc tanks. These tanks must be deep and formed with a ridge in the bottom (*see* B), on which the plates rest while the grit and other impurities settle below them. Plates fixed in flat dishes often appear correctly fixed except for small white (unfixed) patches caused by impurities resting on the film,



A. Wooden Tank B. Porcelain Tank

and preventing the action of the "hypo." In a vertical tank a dozen plates may be fixing at one time, and take up but little room. When a flat dish is used the plate should be film side down, but not with the film in contact with the dish, and then impurities cannot easily attach themselves to the film; even this is not so good as vertical fixing. A shows a form of dish for fixing plates upside down; the long V-shaped wooden trough, covered with pitch or made waterproof and watertight in some other way, is filled with the fixing solution, and the plates rested on the sloping sides film side downwards. An advantage of such a dish is that it may be used for any and all sizes. Such a dish is more cumbersome, and takes up more room, than a vertical trough.

It is not necessary to deal here with the composition of "hypo" fixing baths, as formulæ have been given under the headings "Acid Fixing Bath" and "Alkaline Fixing Bath." While fixing is apparently the simplest of all photographic operations, it is frequently done in an inefficient manner, thus leading to many failures. A common mistake is to remove the negative or print from the "hypo" solution too soon. A negative is not fixed the moment the silver appears to be dissolved away and the plate clear. The process of fixing with "hypo" includes two distinct and important functions. The first is the formation of a double salt of sodium hyposulphite and silver by the reaction of the creamy white silver bromide with the "hypo," at which stage the negative is clear and apparently fixed. The double salt so formed is insoluble in water, and therefore cannot be removed by any amount of washing; it cannot be seen, and the negative appears perfect and ready for washing and drying, but if washed and dried at this stage the double salt will on exposure to light appear in due course as a yellowish stain, and in time the image will fade more or less to an extent corresponding to the amount of the double salt in the film. The second function is the dissolving away of the detrimental salt first formed. Although insoluble in water, a longer soaking in the "hypo" solution converts it into another double salt that water will easily remove; hence the absolute necessity of leaving

the developed plate in the fixing bath for an additional time after the plate appears to the eye to be fixed and clear. Ordinarily, the proper length of time to secure perfect fixation is double that taken by the white substance to dissolve. Thus, for example, if it takes ten minutes' immersion in the "hypo" bath to clear away the last traces of the silver bromide, the plate must be allowed to remain for another ten minutes in order that fixation may be complete.

Some workers advocate a second fixing bath rather than a prolonged soaking in one bath, but if the first bath is fresh, properly mixed, and of the correct strength, a second fixing bath should be quite unnecessary. If the fixing bath is so weak or so loaded with impurities that it is unable to perform its work, it should be discarded, as it is in a condition to do harm a second bath cannot correct.

Where a variety of developers are in use, and if no care is taken to wash the plates thoroughly free from developer before placing them in the fixing bath, there is a possibility of trouble arising if the same bath is in use for all plates; but there is quite as much risk of having the transparency of the gelatine impaired by failure to wash off the developer even when a freshly made bath is used.

A common mistake is to employ "hypo" fixing baths too strong. The silver bromide is less soluble in, say, a 50 per cent. solution than in a 25 per cent. solution. The latter, 4 oz. of "hypo" to 16 oz. of water, is a suitable strength for films and plates, but for papers half or even a quarter strength will serve. When a very weak "hypo" bath is used, the double salt referred to is likely to remain in the film, because there is no excess of "hypo" to act upon it. The bath should not be weaker than 1 in 5 for plates and 1 in 10 for prints. A fixing bath made of the usual strength, the ingredients being properly weighed or measured and not taken by guesswork, and used in sufficient quantity to cover the plate, will contain an excess of "hypo" that will act upon the double salt if time enough be given.

A solution of "hypo" will not attack the actual image which has been developed so long as the plate is well covered with the solution, but when a negative wet with the fixing bath is exposed to the air, the "hypo" in solution, in conjunction with the oxygen of the air, does attack the developed (reduced) silver which forms the image, with the result that the negative becomes thinner. This action is not very rapid, and no appreciable harm is done when the negative is taken out of the bath for examination, and a reasonable time may elapse before it is placed in the washing water; but irreparable damage is done when the plate is left in the fixing bath, or in the washing water after fixing, only partly covered with the liquid. The covering of the plate with a solution of "hypo" and glycerine, and leaving it exposed to the air, is, in fact, a little-used method of reducing.

As regards the exhaustion of the fixing bath, Messrs. A. and L. Lumière carried out some experiments (published in February, 1907), and found that, to avoid subsequent yellowing of negatives on modern gelatine plates, it is advisable (1) to fix not more than one hundred 9 by 12 cm. plates in one litre of 15 per cent solution of "hypo" (this is roughly equal to about 120 quarter-plates in 35 oz.); (2) to fix not more than fifty of such plates (sixty quarter-plates) in one litre of a 15 per cent. fixing bath, plus 1·5 per cent. of bisulphite; (3) to fix not more than seventy-five plates (ninety quarter-plates) in one litre of a 15 per cent. fixing bath plus 1·5 per cent. bisulphite and ·5 per cent. chrome alum. The moment when the fixing bath is used up and should be thrown away can be determined by placing a drop of the bath on white paper, and exposing for some time to light and air; if the spot turns brown, the bath is exhausted.

The function of the fixing solution is the same for prints as for negatives, although the silver salts may differ chemically and may be attacked under different conditions. The porous paper allows the "hypo" to act on both sides of the film, but this is more than counterbalanced by the larger amount of water that must be displaced before the "hypo" can begin its work of dissolving the silver bromide.

While, on the whole, a plain solution of "hypo" is sufficient for the fixing of negatives and silver prints, several additions have from time to time been recommended, some with a view to hardening the film and so prevent frilling and blistering, others to prevent or remove stains from the film, and still others to keep the solution itself from being discoloured in cases where it is employed over and over again. The most harmful, and at the same time the most frequently recommended, addition is common alum, which decomposes the "hypo," liberating sulphur, and forming injurious compounds that may possibly interfere with the fixing, and lead to degradation of the negative or print.

As the result of a series of experiments, Messrs. Haddon and Grundy have stated that the best strength at which to use a "hypo" bath is 10 per cent., and that such a bath will at a normal temperature completely fix a print in ten minutes. As to the exact amount of "hypo" to be used for each print, this depends on many circumstances, but on an average 2 oz. of "hypo" dissolved in 20 oz. of water will thoroughly fix 420 sq. in. of print—that is, one sheet of paper 24 in. by 17½ in., equal to about thirty quarter-plate prints or about ten or eleven half-plate prints. Otherwise stated, it requires approximately from 80 grs. to 90 grs. of "hypo" in the form of a 10 per cent. solution to fix a half-plate print at normal temperature, immersing the print for ten minutes.

In process work, wet collodion negatives are invariably fixed in potassium cyanide, the usual formula being 1 oz. of 30 per cent. cyanide in 20 oz. of water.

FIXING BEFORE DEVELOPMENT

It has been found that whatever the action of light may be on the sensitive silver salts, the result is such that it is not destroyed by fixation; and it has been suggested that when on tour it may be convenient or safer merely to fix the exposed plates and then develop them on the return home. In such a case the developer is a physical one, and the most satisfactory is that given on the next page.

A.	Ammonium sulphocyanide	2,304 grs.	240 g.
	Silver nitrate	384 ,,	40 ,,
	Sodium sulphite	2,304 ,,	240 ,,
	"Hypo"	480 ,,	50 ,,
	Potassium bromide	57 ,,	6 ,,
	Distilled water to	20 oz.	1,000 ccs.
B.	Metol	144 grs.	15 g.
	Sodium sulphite	3 oz.	150 ,,
	Distilled water to	20 ,,	1,000 ccs.

For use, mix 6 parts of A with 54 parts of water, and add 30 to 40 parts of B. As a practical process this is hardly worth trial, as the exposures must be at least four to six times longer than usual.

FIXING BEFORE TONING (*See* "Toning after Fixing.")

FIXING, COMBINED DEVELOPING AND (*See* "Developing and Fixing Combined.")

FIXING, COMBINED TONING AND (*See* "Toning and Fixing Combined.")

FIXING, DEFERRED

A process for treating a negative after development so that fixing may be carried out later. The method is largely used by tourists who desire to see whether exposures have been correct, but who do not wish, for the time being, to go to the trouble of fixing and washing. The plate is developed as usual, washed for about five minutes, and placed in any one of the three following baths, thus rendering the developer inert :—

(1) Potassium bromide ½ oz., water 5 oz.
(2) Alum ½ oz., citric acid 30 grs., water 5 oz.
(3) Cadmium bromide ¼ oz., alcohol 5 oz.

In hot weather add 15 drops of formaline. Five to ten minutes' treatment is sufficient. The safest bath is the bromide bath (No. 1); should the alum bath (No. 2) be used and the plate not be properly washed, ugly stains may appear. With formulæ Nos. 1 and 2, a slight rinsing after the "deferring" bath is necessary, the plate being then dried and fixed at leisure. The advantage of the cadmium bath (No. 3) is that the plate need not be washed either before or after treatment, and the alcohol serves to dry the plate in a very few minutes. Daylight does not injure negatives temporarily finished in this way, and they may even be printed from, preferably upon bromide or gaslight paper.

FIXING WITHOUT TONING

All printing-out papers do not need toning, and in some cases good colours may be obtained by fixing only. (*See* "Self-toning Papers.") Plain salted paper fixes out a pleasing sepia colour, if not too heavily sized. Paper prepared with silver chloride alone comes out of the fixing bath a blue colour, while if the organic salt is chiefly used a foxy red results. A combination of these two colours in right proportion results in a pleasing tone on fixing. Effective red tones may be obtained on ordinary matt P.O.P. by fixing without toning. Printing should be deeper than usual, and the prints washed well before fixing, in order to remove the free silver.

FIXING-HARDENING BATHS

Solutions for hardening the films of plates and papers and at the same time fixing the image. Their use does not yield such permanent results as the use of separate fixing and hardening baths. (*See* "Hardeners.") The best known formulæ are :—

Alum "Hypo"

Alum (saturated sol.)	20 oz.	100 ccs.
Sodium sulphite (saturated solution)	6 ,,	30 ,,
"Hypo" sol. (1 in 5)	20 ,,	100 ,,

Chrome Alum "Hypo"

Add—

Strong sulphuric acid	60 drops	·1 cc.
Water	2 oz.	50 ccs.

to—

Sodium sulphite	2 oz.	50 ccs.
Water	6 ,,	150 ,,

and pour the mixture into—

"Hypo"	16 oz.	400 ccs.
Water	48 ,,	1,200 ,,

Finally add—

Chrome alum	1 oz.	25 ccs.
Water	8 ,,	200 ,,

"Hypo" Acid Sulphite

"Hypo" (in powder)	1 lb.	250 g.
Sodium acid sulphite	2 oz.	32 ,,
Water	64 ,,	1,000 ccs.

The second and third baths, being in an acid condition, must not be used for printing-out papers, and are suitable only for plates and bromide and gaslight papers. The "hypo" and plain alum bath may, however, be used after toning.

Another form of fixing-hardening bath, which is largely used in hot countries and in England during hot weather, is the following:—

Sodium hyposulphite	2 oz.	220 g.
Potas. metabisulphite	¼ ,,	28 ,,
Chrome alum	¼ ,,	28 ,,
Water	10 ,,	1,000 ccs.

First dissolve the "hypo" in 5 oz., half of the water made hot, next the metabisulphite in half the remaining water (cold), and add to the "hypo" mixture; lastly dissolve the chrome alum in the remaining water (cold), and add to the hypo-metabisulphite mixture. Careless mixing causes turbidity, whereas the solution should be clear and of a greenish colour. The above being acid is suitable for negatives and bromide and gaslight prints, but not for P.O.P.

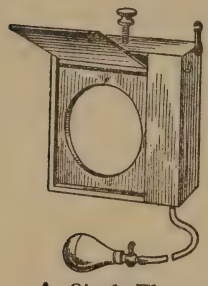
FLAKE WHITE

Basic lead carbonate, used as a white pigment for retouching photographs, etc.

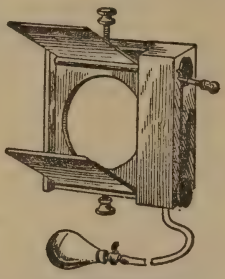
In process work, flake white has been superseded by other pigments, and is now seldom used for retouching photographs for reproduction owing to its tendency to become yellow. The more modern white pigments employed, such as albanine, ullmanine, blanc d'argent, etc., are described under their respective headings.

FLAP SHUTTER (Fr., *Obturateur à volet*; Ger., *Klappverschluss*)

A shutter in which the exposure is made by the rise and fall of a hinged flap. In an early pattern, the flap was actuated by an elastic band stretched from the upper part of the shutter over



A. Single Flap Shutter



B. Double Flap Shutter

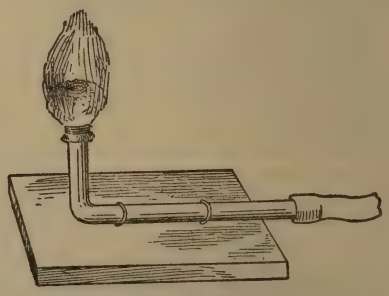
a peg or projection at the bottom of the flap, the latter being released by depressing a catch. The flap fell again by its own weight. This kind of shutter is now seldom seen, except in studio apparatus. A greatly improved modern pattern, arranged to work noiselessly by the pressure of a pneumatic ball, and remaining open as long as the ball is pressed, is illustrated at A. The catch seen on the right is to keep the shutter raised during focusing or for time exposures, by engaging with a bent wire. A double flap shutter is shown at B. Another form of flap shutter is really nothing more than a hinged covering for the lens, lined with velvet and worked by means of a rod projecting outside the camera. With this, however, exposures sufficiently quick for studio work are readily given.

FLARE SPOT

A light patch usually near the centre of a photograph, and caused by internal reflection in the lens. It may usually be obviated by altering the position of the diaphragm, so that the reflected light becomes evenly distributed over the entire field. One form of flare takes the shape of a well-defined inverted image of a window, portion of sky, or other bright object. This is usually termed a "ghost" and may be obviated by the method above indicated. Flare usually appears when using a small diaphragm; hence many lenses which work satisfactorily down to *f*/16 exhibit flare when stopped down to a smaller aperture. (*See also* "False Images.")

FLASH LAMP (Fr., *Lampe éclair*; Ger., *Blitzlampe, Magnesiumlampe*)

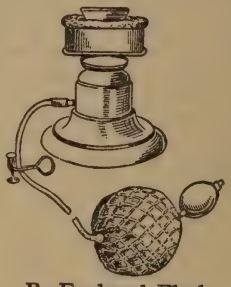
In its original sense, a lamp for burning magnesium powder, which is blown through a spirit or gas flame. A simple type of flash lamp may be made as shown at A, with a short metal pipe bent to a right angle and surrounded with cotton-wool soaked in methylated spirit. A charge of powdered magnesium is placed in the pipe, and the free end is attached to a rubber tube terminating in a ball. The spirit is then lit, and pressure on the ball at the desired moment drives the magnesium into the flame and ignites it. A number of such lamps may be arranged to flash simultaneously by connecting all the pipes to a single large ball, a pair of bellows, a bicycle pump, or an air reservoir. It is always preferable, when extra light is desired, to use several lamps, rather than to increase the charge of powder in a single lamp; as, in the latter



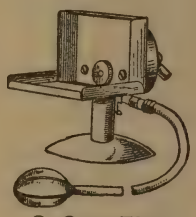
A. Simple Type of Flash Lamp

case, much of the powder may simply be driven through the flame without being consumed, and so be wasted. Flashlight mixtures should on no account be used in enclosed lamps; these are only suitable for plain magnesium powder. A popular commercial flash lamp of the enclosed type, which gives either an instantaneous or a continuous flash, is shown at B. To use this, the metal chamber is half filled with magnesium powder, and about an ounce of methylated spirit is poured into the vessel holding the wick, taking care that none gets into the discharge orifice or over the sides of the reservoir. The rubber tube is then closed by means of the spring clip, and the bladder is inflated until it fills the net. The wick having been lit, a flash of the required duration can now be obtained by pressing the clip. After exposure, the flame is extinguished by replacing a metal cap.

The term flash lamp is now also used for open arrangements in which a flashlight mixture, consisting of magnesium powder mixed with potas-



B. Enclosed Flash Lamp



C. Open Flash Lamp

sium chlorate, or other detonating ingredients, is burnt in a metal tray or pan, by means of a fuse which is operated from a small accumulator, the mechanical striking of a match or percussion cap, or other means. A typical flash lamp of the open type is illustrated at C. The ignition of the powder is obtained in a somewhat novel fashion. A milled disc of a special pyrophorous or spark-giving metal is caused to rotate against a similar

DAWN AND SUNSET — BY (THE LATE) H. P. ROBINSON

COMBINATION PRINTING (FROM PARTS OF THREE NEGATIVES)

metal surface by means of a coiled spring, thus giving off a small stream of sparks as it revolves. The spring is wound up by a key and the powder is spread on the tray around the milled disc, when pressure on the pneumatic bulb at once starts the mechanism and ignites the flash mixture. For professional flashlight purposes, longer trays are commonly used, the powder being laid in a thin, heaped-up line. The lamp is raised to a suitable height by a jointed metal rod attached to a stand; and a screen or cover of muslin, or other light, translucent material, is supported on a frame over the tray to diffuse the illumination.

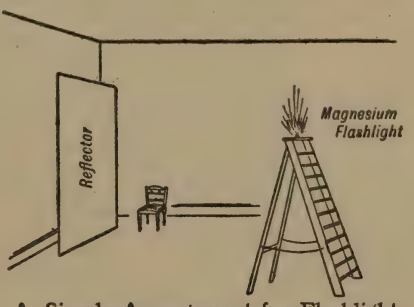
FLASHLIGHT CANDLES (*See* "Candles, Flashlight.")

FLASHLIGHT PHOTOGRAPHY

The taking of photographs by means of flashes of artificial light, the light being generally produced by burning magnesium or flashlight mixtures. Magnesium was made known in 1808 by Sir Humphry Davy, but for half a century or more it was regarded as a curiosity. In 1859 Bunsen, of Heidelberg, and H. E. Roscoe, of Manchester, pointed out the value of magnesium as a source of light for photographic exposures. Improvements in the manufacture of the metal took place (a company being formed in Manchester for the purpose in 1863), but its expensiveness (magnesium in the form of ribbon then cost half a crown per foot) kept its use restricted. A. Brothers, of Manchester, has been credited with taking the first successful photographs with magnesium, for early in 1864 he obtained a stereoscopic negative of a Derbyshire mine, and in May of the same year a portrait of Prof. Faraday, at the Royal Institution. In the following year the interior of the great Pyramid was taken by Prof. P. Smith by magnesium light, since when the metal, in the form of both ribbon and powder, has become cheaper and consequently widely used. The light given off is of intense brilliancy and of high actinic power.

Magnesium for photographic illumination purposes may be obtained in three different forms—pure magnesium powder; flattened wire, known as ribbon; and a combination of magnesium and other substances, in powder. The ribbon is the safest, but does not allow of such short exposures as the powders; however, it is commonly employed in photographing dark corners of rooms, caverns, cellars, etc., where the length of the exposure is not of much consequence, and it is sometimes useful as an accessory to daylight, as a means of illuminating objects in deep shadow, since, on account of its burning slowly, it may be moved about while the exposure is being made, and so give diffused lighting. Another advantage of using ribbon is that the actinic value of the light obtained by burning a definite quantity remains constant under the same conditions, so that by measuring the length—or, preferably, weighing the quantity—of the ribbon before burning, the photographer can easily obtain data that will assist him in making the results of later exposures sure.

For flashlight work proper—that is, for what are known as "instantaneous exposures"—the powders must be used. It is not necessary to employ a shutter as in making instantaneous exposures by daylight; in most cases the ordinary lights of an apartment are too feeble in actinic rays to affect the plate, and the lens is left open until after the flashlight. Magnesium flashes are open to objections: the quantity of smoke produced, and the difficulty of diffusing or spreading the light over a sufficiently wide area



A. Simple Arrangement for Flashlight Portraiture

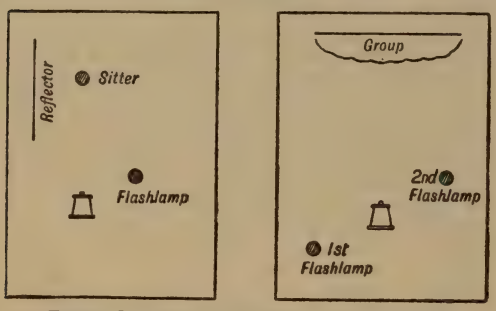
to obviate harsh shadows and hard contrasts. Again, there is the risk of explosion, but such an accident can scarcely occur with careful, proper firing. Pure magnesium powder gives a bright and highly actinic flash, but it must be *blown through a flame.* Flashlight powders containing substances in addition to magnesium are really explosive mixtures, and they must be ignited *by applying a light,* for should they be blown through a flame a dangerous explosion will result. A flashlight compound must not be used in a closed storage reservoir or magazine lamp, because in these the flame would travel to the bulk and explode it. Only the pure magnesium powder should be used in such lamps. For the beginner, the ribbon is the safest and the pure powder the next safe.

As regards the amount of powder to be used, this depends upon nearness of subject, stop, plate, etc., but the table given below (compiled by J. H. Crabtree) may be taken as a guide:—

Distance of main object	*Size of Room*			*Weight of Magnesium required*	
	Length	*Breadth*	*Height*		
Feet	Feet	Feet	Feet	Grains	Oz. (approx.)
9	15	6	10	15	—
15	20	6	10	30	—
20	25	10	10	75	—
25	30	12	10	120	¼ plus
30	35	12	10	180	
35	40	15	10	230	½ plus
40	45	15	12	300	—
45	50	20	12	370	—
50	60	20	12	460	1 plus
55	65	20	12	560	1¼ plus
60	70	30	15	680	1½ plus
65	75	30	15	780	1¾ plus
70	85	30	15	900	2 plus
75	90	40	15	1020	2⅛ minus
80	95	40	15	1200	2¼
85	100	45	20	1340	3 plus
90	120	45	20	1500	3½ minus
95	125	50	20	1650	3¾
100	130	60	20	1850	4¼

The conditions assume a lens at *f*/11 and a fairly rapid plate, the exposure being so short as to be regarded as instantaneous. It is also important to bear in mind that the quantities specified must be completely burned in the flame with an ample supply of air, and not half consumed or wasted.

Lighting and Arrangement of Subject.—Success in group and portrait photography by flashlight depends chiefly upon the arrangement of the light and sitter. A frequent mistake is to have the light at too low a level; it should be at least 1 ft. above the level of the sitter's head, and not on a level with it or lower. The higher the light (in reason) the more truthful will be the effect, and the less like the generality of flashlight photographs, which are distinguished by the glaring whites of the eyes and the harsh blacks and whites. In portraiture it is a good plan to place the flash powder on steps as at A (*see* preceding page), or if ribbon is used the operator may stand on the steps and wave the ribbon about, or the ribbon may be tied to a stick and waved about on high. At B is shown the plan



B and C. Plans and Arrangements for Flashlight Portraiture

of a suitable arrangement for taking portraits by flashlight; a reflector of white material is needed on the shady side of the face, or if there happens to be a white wall surface on that side it will serve the purpose. Whitewashed ceilings serve admirably as a top light, as they reflect downwards an enormous amount of actinic light when the magnesium is fired. The light is placed and fired at a point on one side of the camera, but slightly nearer than the camera to the figure, yet not so near as to be included in the view; the flash must not be reflected in the lens, or the plate will be fogged. By varying the positions of camera, sitter, light, etc., any number of different effects can be obtained in one room. If there is nothing acting as a reflector on the shady side of the sitter, it will be necessary to interpose a sheet of white tissue paper or muslin between the flash lamp and the subject in order to diffuse the light and obtain softness in the photograph. Frequently it is the nearness of the light as well as its low position that gives a ghostly effect to flashlight portraits. The diffuser is useful in the majority of cases, and although it stops a little of the light and may mean a few extra grains of powder, the results obtained will be softer and better. In group work, two or more lamps may be necessary, in which case one lamp should be much nearer to the group than the others (*see* C), all the lamps being fired at the same moment. Professionals frequently employ electrical arrangements to synchronise the ignition when more than one lamp is in use. The near lamp serves as the main light, and the other as a kind of auxiliary lamp to assist generally and light up to a small extent what would be the shady side.

In flashlight photography all the gas, electric, and other lights may be left burning, as they do not much affect the plate during the extremely short exposure. If the image cannot be seen on the ground glass sufficiently distinct for focusing, the sitter or sitters can hold a candle or a lighted match on a level with the face, and the flame can then be focused. The plate is then put in, the dark-slide shutter is drawn, and the cap taken from the lens or the shutter opened, the exposure being made by firing the powder or ribbon. Only that part of the exposure made during the burning of the magnesium need be taken into consideration.

One of the great drawbacks to the use of flashlight is the immense amount of white smoke given off. All windows and doors may therefore with advantage be opened; and the smoke of one flash must be got rid of before another exposure is made. The smoke is quite harmless. Some of the patent commercial mixtures cause less smoke than others, while some of the more expensive and complicated flash lamps have smoke-catching devices. A home-made smoke-catching device is formed by placing the flash lamp in a large box stood on its end with its open side towards the subject; after exposure the lamp is immediately taken out, the box closed with a cloth or tightly fitting lid, and the whole taken to an open window or outside and emptied; but the arrangement prevents much valuable light reaching the ceiling and walls.

Outdoor work with flashlight differs but slightly from the above, but more light is required, and there is little or no trouble with the smoke. More powerful (consequently more explosive) mixtures, of the firework type, can be used, as the risk of danger to human beings is so much less.

Flashlight work is not confined to portraits, groups or evening work generally, but is of great service in illuminating dark corners in interiors, such as crypts, workshops, underground workings, etc., in the daytime. For this purpose ribbon is better than powder, but care must be taken to keep the naked light and the smoke from it out of the view of the lens, with which object the flash lamp may be fired behind a pillar or something of the sort.

Any developer will, with care, serve for developing flashlight exposures, but as there is always a risk of under-exposure and harsh contrasts, little or no bromide should be used, and the developer should be diluted with water. The following hydroquinone-eikonogen developer has been widely recommended for flashlight exposures, but metol-quinol and similar developers can be made to give equally good results:—

A.	Hydroquinone .	½ oz.	11·1 g.
	Eikonogen . .	½ „	11·1 „
	Sodium sulphite .	2½ „	55·5 „
	Hot water to .	45 „	1,000 ccs.

Dissolve the sodium sulphite, then the eikonogen, and finally the hydroquinone.

B.	Sodium carbonate	2½ oz.	55·5 g.
	Hot water . .	15 ,,	333 ccs.

For use take 3 oz. of A, 1 oz. of B, and 3 oz. of water; this forms a normal developer which should give a good negative in from eight to ten minutes.

FLASHLIGHT POWDERS

The chief two kinds of flashlight powders are (1) pure magnesium powder and (2) mixtures of magnesium and other substances. Magnesium powder used alone is blown through a flame, the brightness and duration of the flash depending upon the quantity of powder burnt and upon the length of time taken in passing it through the flame. Some arrangements for firing permit of a slow passage of the powder through the flame, in which case the light is continuous, and not an instantaneous flash; others permit of a large quantity of the powder being passed through a flame very quickly, in which case there is frequently a risk of much of the powder being wasted.

Flashlight mixtures are explosive, and in their action behave like gunpowder; they must not be blown through a flame, but must be placed in a heap or a ridge and the light applied, the result being a momentary flash of high actinic power. Such explosive mixtures must always be looked upon as being more or less dangerous. The addition of chemicals to the magnesium is for the purpose of increasing the rapidity of the combustion and the actinic power of the light. When such mixtures are made by the worker, the ingredients should be purchased in the powder form and then mixed carefully together on paper with a dry feather. Large quantities should never be mixed for fear of explosions, and for the same reason there should be no lumps of any kind in the mixtures. The ordinary photographer will be well advised in buying his flashlight mixtures ready prepared. Some of the best known formulæ are:—

(1)	Magnesium . . .	6 parts
	Potassium chlorate . .	9 ,,
(2)	Magnesium . . .	6 ,,
	Potassium chlorate . .	4½ ,,
	Potassium perchlorate .	4½ ,,
(3)	Magnesium . . .	6 ,,
	Potassium chlorate . .	12 ,,
	Antimony sulphide . .	2 ,,
(4)	Magnesium . . .	16 ,,
	Potassium perchlorate .	12 ,,
	Potassium nitrate . .	12 ,,
(5)	Magnesium . . .	48 ,,
	Ammonium nitrate . .	3 ,,
	Strontium oxalate . .	5 ,,
	Sodium oxalate . .	5 ,,
(6)	Magnesium . . .	40 ,,
	Potassium perchlorate .	60 ,,
	Sodium chloride (salt) .	5 ,,
	Barium tartrate . .	7 ,,

Nos. 1 and 2 are good average mixtures for home work or professional portraiture. No. 3 gives a very good light, but its fumes are poisonous, and it should therefore be used in the open air or in a well-ventilated room where the fumes can escape quickly. No. 4 burns rapidly, and is less liable to explode. No. 5 is for isochromatic plates, and a yellow screen should be used in the lens. No. 6 is for isochromatic plates, but a yellow screen need not be used.

Aluminium is said to give less smoke than magnesium, but it yields only about two-thirds of the actinic light. The following mixture of aluminium and magnesium not only gives less smoke than a mixture containing chlorate, but the smoke quickly passes away and the powder is non-explosive:—

Copper sulphate (anhydrous)	6 parts
Magnesium powder . .	3 ,,
Aluminium powder . .	1 ,,

This gives much less smoke than mixtures containing chlorate, and the smoke passes away quickly, thus allowing of a series of successive exposures in a room. (*See also* "Aluminium Flashlight.")

There are many other formulæ for flashlight mixtures, but they are similar to the above.

Great care is necessary when firing flashlight mixtures; and when no proper lamp is used the powder is best placed on a small iron slab or tray and fired by means of touch-paper (*which see*), or by means of a long taper or of a match fixed to a stick, the operator turning his head away when the actual flash takes place.

Slow-burning mixtures may be made, the following being a typical formula:—

Magnesium powder . .	100 parts
Ceric nitrate . .	70 ,,
Strontium carbonate . .	30 ,,

Eighty grains of this powder burn in about six seconds.

Flash-sheets are made by soaking thin blotting-paper in a strong solution of saltpetre, drying, and then spreading over the paper pure dried, unoxidised magnesium powder, leaving the edges free. Such a sheet constitutes a combined slow-match and flashlight, it burning slowly until the smoulder reaches the powder, which then bursts into a bright flame. Flash-sheets are quite safe in use; a commercial form is a mixture of fine magnesium powder and celluloid spread on glass and allowed to dry.

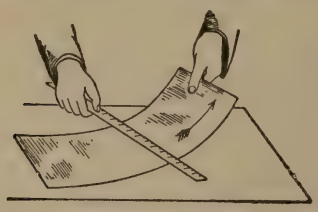
FLATNESS

A term applied to a print in which there is but little contrast between the lights and shadows. It is the opposite quality to brilliance. An over-exposed and under-developed negative gives a flat result.

FLATTENING PRINTS

Prints that are not dried under pressure invariably curl up. Prints on collodion paper may be dried between blotting-paper under pressure, but gelatine prints—ordinary P.O.P., bromide and gaslight papers—cannot be treated in this way, because of the sticky gelatine surface. Sometimes even collodion prints will curl badly when removed from pressure. A rough and ready method of flattening is to roll the dry prints all together film side outwards, and secure with an elastic band; after a few hours they will be found on unrolling to be flat. A better method is here illustrated. The curled

picture is laid face downwards on a clean flat surface, and a flat ruler is then placed along one edge of the print and pressed down firmly.



Flattening Prints

Next, the whole print is drawn sharply under the ruler, as illustrated, the ruler being kept stationary. The process may need to be repeated once or twice.

FLEXIBLE SUPPORT (*See* "Temporary Support.")

FLORENTINE FRAMES (Fr., *Cadres florentins ;* Ger., *Florentinischer Rahmen*)

Ornate gilt frames with open-work foliated ornament ; suitable for photographs worked-up in water-colours, crayons, etc., when not on too large a scale.

FLOWERS OF SULPHUR (*See* "Sulphur.")

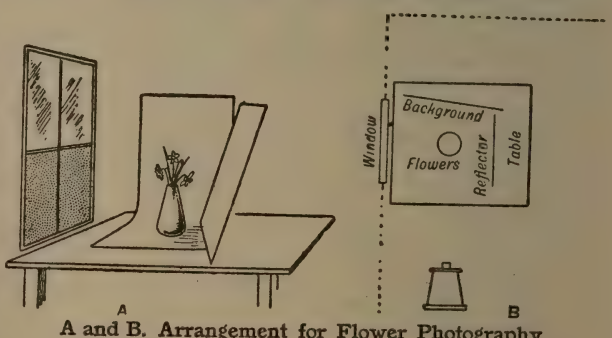
FLOWERS AND FRUIT, PHOTOGRAPHY OF

In this work success depends on the lighting, the arrangement of the subject, and the method of exposure. Flowers and fruit may be photographed indoors or out, in their natural surroundings or otherwise ; but the best results are obtained by arranging them indoors and in a suitable light. A convenient method of arranging the lighting is shown at A and B. On a table near a window on the shady side of the house the flowers (or fruit) are arranged, the background being a sheet of brown or other coloured paper, according to the tint required in the photograph. It is advisable to have papers of several different colours at hand, and to bear in mind their different photographic values. The light should come in at the window and be fairly strong, as then, by means of tissue paper over the lower half of the window and a white cardboard reflector on the shady side of the subject, the light may be controlled to a nicety. The positions of the camera, flowers, background, etc., are all subject to experiment in obtaining various effects. It is not always advisable to show the vase which contains the flowers or the means of supporting the fruit. In the case of a few blooms, they may be stood in a narrow-necked bottle in order to keep them upright, and the stalks must be long if the neck of the bottle is not to be included in the picture. Other supports include a bowl of wet sand ; bent strips of sheet lead ; and a large potato, the stalks in all these cases being long. For the purpose of picturing the vase as well as the flowers or fruit lying upon the table, there should be no dividing line between table and background, for which purpose the paper forming the background should be brought in a gentle curve underneath the vase, etc. Even if a line would enhance the pictorial value of the picture, it should not be abrupt. The table-cloth must not be of a pronounced pattern, or of a colour contrasting too strongly with the background.

Cameras are sometimes used vertically for photographing flowers that are lying, for example, on the floor. Similar results may generally be obtained with an ordinary camera used in the usual way, by arranging the vertical background to take the fruit or floral sprays ; this may be done by using stout, stiff cardboard covered with coloured paper as the background and pushing pins through from the back, their points serving as rests and being covered by the objects photographed, although if they are not hidden they will be scarcely noticeable.

Cut flowers may be preserved for photographic purposes by sprinkling them with fresh water, and while wet placing in a vase containing the following solution : Water 4 oz., curd soap 2 drms., common salt 8 grs. The soap is cut into shreds and dissolved in the water, adding a small pinch of borax and the salt. If the flowers are to be kept for several days their stalks should be rinsed under the tap daily for a minute or so, the petals sprinkled, and the flowers put back into the vase.

The lens stop plays an important part in the pictorial rendering of flowers. *f*/16 gives general sharpness, but a smaller one may in some cases be necessary. Exposure should not be unduly prolonged, as some flowers—poppies, for example—are apt to droop during a long exposure and show signs of movement upon the plate. Isochromatic plates are the best for most flowers, but ordinary plates may be used for some with good results, everything depending upon the colour of the flowers. For reds, blues, yellows, and various shades of green an isochromatic plate is indispensable to give the proper values of the colours. Much may be done on ordinary plates by giving a suitable exposure—that is, one sufficiently long to enable the colours of little actinic value to register themselves on the plate. E. Seymour has used a yellow screen and isochromatic plate for only about 10 per cent. of his exposures, as in



A and B. Arrangement for Flower Photography

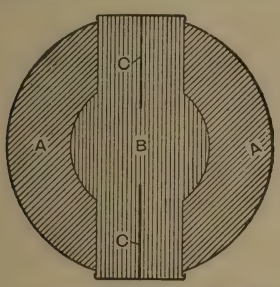
his opinion the use of a screen robs the picture of half-tone and gives an effect unsatisfactory to the observer of nature. Opinions differ, however, but there can be no doubt that to give the plate a full exposure for the deepest shadows and to develop until the highest light is of the correct density, is a thoroughly reliable method of working. In ordinary photography the goal of development is detail in the shadows, but if this is applied in flower photography, the high lights may become blocked up and too dense. Detail in the highest lights is the secret of successful flower and fruit studies; there will always be detail in the shadows if the exposure has been sufficient. The plate should on no account be over-developed, and the following pyro-soda developer is specially recommended:—

A.	Potassium metabisulphite . .	15 grs.	1·5 g.
	Pyro . . .	130 ,,	13 ,,
	Water . . .	20 oz.	1,000 ccs.
B.	Sodium sulphite .	2½ oz.	125 g.
	Sodium carbonate	2 ,,	100 ,,
	Water . . .	20 ,,	1,000 ccs.

For normal exposures take 3 parts of A and 1 part of B. For under-exposure, add more of B and dilute with water.

FLUID LENS

A glass shell, which may or may not have optical qualities in itself, filled with liquid. This arrangement is of considerable antiquity, and has from time to time had photographic uses. A fluid condenser made by Daguerre is still in



Section of Fluid Lens

existence; while Scott Archer, Thomas Sutton, and later Dr. Grün, all constructed lenses in which liquids played an important part. With the Sutton lens (*see* illustration) an extremely wide angle was obtained, but in the Archer and Grün lenses the special object was to gain "rapidity." In the illustration, A indicates glass, B water, and C the diaphragm. The Grün lens was said to contain cedar oil.

FLUID MEASURE

(*See* "Weights and Measures.")

FLUORESCEÏN

(*See* "Eosine.")

FLUORESCENCE

Certain substances have the power of altering the wave-lengths of the light or electric rays which fall upon them. Such bodies, when illuminated by ultra-violet light, become visible in darkness to the naked eye by emitting yellow, green, blue or blue-violet rays, commonly termed fluorescence. Quinine sulphate, calcium tungstate, and barium platino-cyanide are typical fluorescing substances. Many aniline dyes, particularly fluoresceïn, have considerable fluorescing properties, eosine, for instance, giving a green fluorescence. In most cases the colour of the fluorescence given by dyes is complementary to the colour of the dye itself.

FLUORESCENT SCREENS

These are largely used in radiography. They are made by coating a suitable fabric with barium platino-cyanide, calcium tungstate, or other substances which fluoresce when exposed to X-rays. These screens, when used in a dark chamber, permit of the visual examination of objects placed between the X-ray tube and the fluorescing screen, the form and, to a limited extent, the structure of objects appearing as shadows on the screen. Of late years fluorescing screens have been popular for shortening the exposure in X-ray photography; they are placed in contact with the sensitive film of the dry plate, and the fluorescence in conjunction with the direct action of the X-rays on the plate materially shortens the exposure. Fluorescent screens made of quinine sulphate are used to detect the presence of ultra violet light.

FLUORESCENT TUBES

Vacuum tubes, for use with electric currents, which contain traces of gases after almost complete exhaustion. When a high potential current is passed through such a tube it glows with various colours, each gas giving off a distinctive fluorescence. Fluorescent tubes are much used in spectroscopic analysis to determine the nature of gases. These spectra consist of bright lines only. X-ray tubes fluoresce owing to the small quantity of residual air they contain after exhaustion.

FLUORHYDRIC ACID

(*See* "Hydrofluoric Acid.")

FLUORIC ACID

Another name for hydrofluoric acid (*which see*).

FLUORIDE

(*See* "Potassium Fluoride," etc.)

FLUOROTYPE

An obsolete process (invented by Robert Hunt in 1844) for obtaining pictures upon paper in the camera, so called from the introduction of the salts of fluoric acid. The solutions were:—

A.	Potassium bromide	20 grs.	20 g.
	Distilled water .	1 oz.	500 ccs.
B.	Sodium fluoride .	5 grs.	5 g.
	Distilled water .	1 oz.	500 ccs.

These were then mixed together, spread on plain paper, and dried; the prepared paper was next treated with 60 grs. of silver nitrate dissolved in 1 oz. of water. The paper was given about half an hour's exposure in the camera, then soaked in water, a weak solution of iron protosulphate brushed over it, washed in water acidulated with hydrochloric acid, and fixed in either plain water or a weak solution of sodium hyposulphite; finally it was washed well.

FLUOSILICIC ACID

More correctly known as "Hydrofluosilicic Acid" (*which see*).

FOCAL APERTURE

The effective aperture of a lens expressed as a fraction of its focal length. When the object is at a considerable distance from the lens this is a fixed quantity for each stop, but when copying, the focal aperture becomes less in proportion to the size of the image. Thus a lens working with its largest opening at *f*/8 on a distant object has its intensity reduced to *f*/16 when copying to equal size, and to *f*/32 when enlarging to three diameters. The relative exposure necessary with any given lens working at varying camera extensions may be obtained by increasing the exposure required for a particular aperture at the normal focus in the proportion of the squares of the normal and temporary focal lengths respectively. Thus, if a lens having a normal focal length of 6 in. is used with a camera extension of 9 in., the exposure with any stop will be increased in the proportion of 81 to 36; in other words, 2¼ times the normal exposure will be required.

FOCAL LENGTH (Fr., *Longueur du foyer*; Ger., *Brennweite*)

The distance between the centre of a lens and the screen or plate upon which the image of a distant object is sharply depicted. This definition, however, is only correct in the case of a very thin lens, in which the thickness of the glass does not come into consideration, and in which there is only one element. In the case of modern photographic lenses, "focal length" is often taken to mean "equivalent" focal length; that is to say, when a lens will render the image of a distant object on exactly the same scale as would a very thin spectacle lens, the two are said to be of the same equivalent focal length. Equivalent focal lengths vary in direct proportion to the size of the image obtained; thus, assuming that a 6-in. lens gives a 3-in. image of a distant object, an 18-in. lens will give a 9-in. image of the same object. This fact enables the measurement of the focal length of any lens to be effected by simple comparison of its image with a similar image made by a lens of known focal length, or, better still, with a pinhole image. A practical method is to substitute for the lens a fairly small pinhole, the camera being extended to a convenient length (a length of 10 in. simplifies the slight calculation necessary), and to take a negative of some distant object having two easily recognisable points, such as chimneys or telegraph poles, these being shown a few inches apart. The distance between these two points is carefully measured and becomes a constant factor in determining the focal length of any other lens which can be focused upon the same object. Assume that the distance between the points is 4·5 in. Taking a lens of unknown focal length, it may be found, for example, that the images of the two selected points are 3 in. apart; then as 4·5 is to 3 so is 10 to x. $3 \times 10 \div 4{\cdot}5 = 6{\cdot}66$ in. An approximately correct result may be obtained by focusing a near object so that it appears in natural size upon the screen; then one-fourth of the distance between the object and the focusing screen is the focal length of the lens.

The focal length of negative lenses may be ascertained by neutralising them by placing positive lenses in contact with them until one is found that practically loses its convergent powers; then the concave lens is said to have a negative focal length equal to that of the positive lens which it neutralises. Dallmeyer's method is to place a diaphragm, containing two small openings, in contact with the negative lens, which is then turned to the sun; the light passing through these two small openings is received upon a white card, which is moved away from the lens until the two spots of light are double the distance apart as compared with the openings in the diaphragm; then the distance between the diaphragm and the card is the negative focal length

FOCAL PLANE SHUTTER

A shutter that works immediately in front of the plate, and now commonly fitted to the highest class cameras. It is believed to owe its practical form to B. J. Edwards, who in 1884 published a description of his apparatus; but some eighteen or twenty years previously the principles were known to William England, who used a crude device working on the same principle a long time before Edwards's ideas were published. England's device was a board containing a horizontal slit which travelled in front of the plate in the same manner as the drop shutter of the present day travels in front of the lens, and it was caught in a kind of bag suspended from the camera. A shutter of a similar nature had previously been experimented with by Dr. Mann, who recognised its power to utilise the whole of the light admitted by the lens. From 1882, in which year Edwards lectured upon his invention before the old South London Photographic Society, until 1892, the focal plane shutter seems to have been lost sight of, but in the latter year the Thornton-Pickard Company placed upon the market their now well-known shutter of this type, and, simultaneously, Stolze and Ottomar Anschutz, quite unknown to each other, were both working to the same end—the simplification and perfection of the shutter, more particularly, perhaps, in the means of adjusting the slit.

The principle of the shutter is as follows:—A roller blind, containing a slit or aperture the whole length of the plate, is made to travel immediately in front of the sensitive surface. Assuming that this gives an exposure of $\frac{1}{20}$th of a second, by reducing the slit to one-fifth of its original width the exposure is reduced to $\frac{1}{100}$th of a second; again, by increasing the tension of the spring by five or ten times an exposure of $\frac{1}{500}$th or $\frac{1}{1000}$th of a second respectively is obtainable. Most subjects come within the range of $\frac{1}{500}$th to $\frac{1}{30}$th of a second. The efficiency of the focal plane shutter is greater than that of the lens shutter; some types of lens shutter pass for only a very small proportion of the total exposure the whole of the light that the lens is capable of transmitting, much of the time of exposure being taken up by the shutter in uncovering and then covering the lens, there being only a brief period when the lens is quite

uncovered. With the focal plane shutter the whole of the light admitted by the lens is available for action upon any particular portion of the plate uncovered by the slit; and another advantage is the high speed at which the shutter can work, rendering it indispensable for "instantaneous" work of any kind.

It is sometimes affirmed that the focal plane shutter gives distorted results, but its advocates affirm that the distortion (if any) is practically negligible. In practice, distortion may be divided into two classes: (*a*) that in which the outline of any one body is rendered untruthfully, and (*b*) that in which the relative position of a group of figures or objects is incorrectly delineated; this latter may, of course, include the former, and of the two is the more serious. While it matters but little if an image of, say, a rapidly moving railway train is slightly longer or shorter than would be the case were the train photographed at rest, it is a serious matter if the result of a closely contested cycle race is rendered incorrectly. To minimise any possible error, the following points on the correct use of the shutter should be remembered. If the image (on the focusing screen) of the subject being photographed is rapidly moving in the same direction as the slit in the shutter, the slit must be made to move at a much greater speed than if the image and slit were travelling in opposite directions. The use of a shutter travelling at great speed in an opposite direction to that of the image has a tendency to shorten the object, while, on the other hand, the use of a shutter travelling in the same direction as the image may lengthen it. But such distortion is so trifling that it would be practically impossible to discover it. When engaged in high-speed work a good distance at which to work is about seven or eight yards from the subject. Using a 6-in. lens at a distance of eight yards, for objects moving at right angles to the camera these exposures would be about correct:—

Trains, horses galloping, cycle racing, etc.	$\frac{1}{1200}$ sec.
Men racing, jumping, etc.	$\frac{1}{600}$ sec.
Diving	$\frac{1}{300}$ sec.

If the object is taken end on—that is, coming towards, or receding from the camera—exposures three times as long as the foregoing may be given. By doubling the distance from the object, the length of exposure may be doubled.

To develop plates which have received a minimum of exposure, a very energetic developer must be employed. The following formula is recommended, using equal parts of A and B:—

A.	Pyrogallic acid	40 grs.	4·4 g.
	Metol	35 ,,	3·8 ,,
	Potassium metabisulphite	90 ,,	10 ,,
	Potassium bromide	15 ,,	1·6 ,,
	Water to	20 oz.	1,000 ccs.
B.	Sodium carbonate	3 oz.	164 g.
	Water to	20 ,,	1,000 ccs.

FOCI

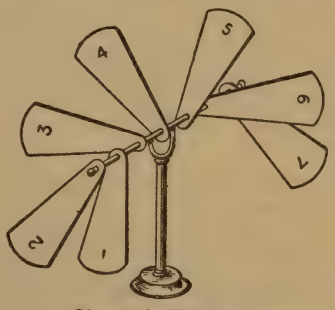
The plural of focus (*which see*).

FOCI, CONJUGATE (*See* "Conjugate Foci.")

FOCI, VARIABLE (*See* "Telephoto Lens.")

FOCIMETER (Fr., *Focimètre;* Ger., *Fokusmesser, Brennweitemesser*)

An instrument invented by Antoine J. F. Claudet, and used to test whether the chemical and visual foci of a lens coincide, that is, whether the lens is achromatic. It consists of a series of cards with different letters or numbers arranged radially on a horizontal rod, one behind the other, as illustrated. The middle card is focused sharply with the full aperture of the



Claudet's Focimeter

lens to be tested, a plate being then exposed and developed. If the card focused is perfectly sharp in the resulting negative the lens is properly achromatic; but if one of the other cards is sharper, the chemical focus of the lens does not agree with the visual focus. By focusing the card that is rendered sharply in the negative and noticing the extent to which the screen has to be moved from its former position, the difference between the two foci and the exact degree of correction required will be ascertained. Several modifications of this apparatus have been suggested.

FOCISCOPE

A focusing eyepiece introduced by Penrose, the lens consisting of three elements cemented together, forming a very powerful magnifier of fairly flat field. It is useful for examining half-tone dot images.

FOCOMETER (Fr., *Focomètre;* Ger., *Fokomesser*)

A lens-testing apparatus designed by Thomas R. Dallmeyer, for ascertaining the focal length of a lens, and the degree to which the various aberrations are corrected, or otherwise. It is essentially a type of optical bench.

FOCOPLANE

Focal plane; *see* "Focal Plane Shutter."

FOCUS (Fr., *Foyer;* Ger., *Brennpunkt*)

Plural, foci. The point at which the rays of light emitted by any luminous body converge after passing through a lens to form the image of such a body. The position of the focus is simply demonstrated by using the lens as a burning glass. The focus of a lens is a position and not a distance, although the word is often so misused (*see* "Focal Length"). The focus for distant objects is often called the principal or solar focus.

FOCUS ADJUSTER (Fr., *Ajusteur de foyer ;* Ger., *Fokusordner*)

An arrangement for lengthening or shortening the focal length of a lens, by the use of a single supplementary lens, or a series of such lenses of varying foci. A device described by John Traill Taylor consisted of a movable brass sliding piece, for which an opening was provided in the lens mount between the combinations. In the sliding piece were four apertures, each fitted with a thin achromatic negative lens. The appliance was designed for use with a doublet composed of two slightly meniscus lenses, which by themselves did not give a flat field. With the focus adjuster, the focal length of the objective was increased to 7, 9, 12, or 15 inches, according to which of the four concave lenses was used, the field at the same time being flattened and the marginal pencils corrected at a fairly large aperture.

FOCUS, DEPTH OF (*See* "Depth of Definition, etc.")

FOCUS, EQUIVALENT (*See* "Focal Length.")

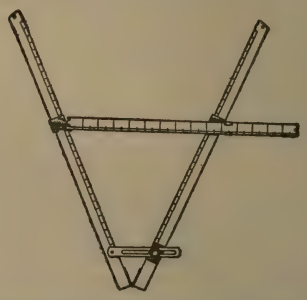
FOCUS TUBE (*See* "Crookes' Tube.")

FOCUSER (*See* "Focusing Magnifier.")

FOCUSING (Fr., *Mise au foyer, Mise au point ;* Ger., *Einstellung*)

The action of adjusting the extension of the camera until the image is sufficiently sharply defined on the ground-glass focusing screen. A focusing magnifier assists in determining when the image is sharp by allowing slight differences in crispness to be more easily seen. As all the planes of a subject cannot be equally well defined, it is important to recognise which should show the most critical definition. Objects near the eye should naturally show greater sharpness than those farther away. But, in addition, the principal object in a picture should show the best definition, should any differences exist. Where there is a number of objects at different distances, and it is desired to secure a uniform degree of sharpness between the nearest and the farthest, it is advisable to focus on a point beyond the nearest object, about one-fourth of the distance from the nearest to the farthest.

In process work, several schemes have been proposed for automatic focusing. Some elaborate mechanical inventions have been devised for moving the camera to and from the copyboard at the same time as the focusing screw is turned to move the ground glass of the camera, but none of these arrangements has come into practical use. A more convenient method, which can be applied to any camera and stand with little alteration of existing arrangements, is the Scalometer system, invented by L. Emmett. The scalometer is an instrument made in boxwood, opening like a two-foot rule, there being on the two limbs similar scales of equal divisions numbered from the ends of the limbs. A cross rule divided into inches or centimetres bridges the angle formed by the opening of the two limbs. In operation the points or ends of the limbs are applied compass-like to the sides of the original, and then clamped at this separation. The cross rule is then made to slide up and down until it indicates across the angle formed by the limbs the measure of the desired reduction. At this point the proportional number on the two limbs is read off, and is marked on the back of the original. Then all originals which bear the same proportional number can be photographed



Scalometer for Facilitating Focusing

together. By means of a printed scale supplied with the instrument it is possible to mark off the copying stand with numbers corresponding to those on the limbs of the instrument, so that the camera can be instantly set to the proportion number marked on the original, without the necessity of focusing.

FOCUSING CAMERA (Fr., *Chambre à foyer réglable ;* Ger., *Einstellungs-kamera*)

Any camera in which different distances can be focused for, as distinguished from fixed-focus cameras, which do not permit of adjustment. Self-focusing cameras are those which extend automatically to the correct focus for any given distance, on setting a pointer or turning a key on a marked dial. Such adjustments are usually only to be found on hand cameras.

FOCUSING CLOTH (Fr., *Voile, Voile noir, Voile de chambre, Voile de mise au point ;* Ger., *Einstellungstuch, Kopftuch, Schwarze Leinwand*)

Synonym, black cloth. A cloth used to cover the back of the camera and the operator's head when focusing, in order to exclude extraneous light, which would interfere with the visibility of the image on the ground-glass screen. It is also employed to shield the top of the dark-slide when withdrawing the shutter, and not infrequently to wrap up the slides after the exposures have been made. It is usually made of black velvet or twill, which may or may not be lined with yellow or red cloth, or of waterproof cloth. A cloth is more convenient in use when provided with cords at the corners for tying to the camera in windy weather; whilst a loop in the middle of one side, to slip over the lens, is always useful. For a small camera, the focusing cloth may be about 3 ft. square.

FOCUSING GLASS

A name for the focusing magnifier (*which see*). The term is applied occasionally to the focusing screen of the camera.

FOCUSING JACKET, OR RACK MOUNT (Fr., *Tube à crémaillère ;* Ger., *Zahnstange Objektivrohr*)

A form of lens mount provided with an inner tube carrying the glasses, which slides to or fro by an attached rack and pinion. This kind of mount is found on lantern, enlarging, and kinematograph objectives, and some portrait lenses. For lantern and kinematograph use, the jacket is sometimes supplied empty, to allow of the insertion of different objectives in loose interchangeable tubes or cylinders.

FOCUSING MAGNIFIER (Fr., *Loupe, Loupe de mise au point ;* Ger., *Einstelloupe*)

Synonyms, focuser, compound focuser, focusing eyepiece, focusing glass. A lens used when more accurate focusing is desired than is obtainable on the ordinary ground-glass screen, as may be necessary in photo-micrography, process work, etc. It is usually composed of two plano-convex lenses of identical focal length, mounted with their plane sides outward at a distance apart equal to two-thirds of the focal length. The

Focusing Magnifiers

lenses should preferably be achromatic, though this is not indispensable. To use the magnifier, a piece of plain plate glass having a few fine black lines ruled on it is substituted for the ground-glass focusing screen ; or, as an alternative, several microscopic cover glasses may be cemented at suitable spots on the ground glass by means of Canada balsam, having first made a pencilled cross on the ground surface where each glass is to be attached. The magnifier is adjusted by sliding or rotating the upper tube, till the ruled lines or pencilled cross, as the case may be, are in sharp focus, when it only remains to see that the image on the screen is in focus at the same times as the lines or cross. The magnifier gives an enlarged image, and naturally a brighter one than can be obtained on ground glass. A shows a magnifier with screw adjustment and clamping collar ; B shows one with an Archimedean screw movement ; C has an erecting lens to show the image the right way up ; while D is provided with a bayonet tripod by which the magnifier may also be raised to examine prints, half-tone blocks, etc., if required.

FOCUSING NEGATIVE LENS (*See* "Negative Lens.")

FOCUSING SCALE (Fr., *Échelle de mise au point ;* Ger., *Einstellskala*)

A graduated scale or dial fitted on hand cameras, enabling objects at various distances to be focused, by the movement of a pointer, without inspecting the screen.

FOCUSING SCREEN (Fr., *Verre douci, Glace doucie ;* Ger., *Visirscheibe, Mattscheibe, Mattglas, Mattglasscheibe*)

The screen upon which the image formed by the camera lens is focused, before exposing the plate, in order to secure sharp definition. It is usually of glass ground on one side to a matt surface. Some of the ground-glass screens supplied with the cheaper cameras are extremely coarse. A finely ground glass is, however, on the market in the usual cut sizes at very reasonable prices. A good substitute, having the advantage of being light and unbreakable, is a sheet of matt celluloid ; but care must be taken that this does not buckle, or it will not agree in register with the dark-slide. For this reason celluloid is scarcely suitable for large cameras.

Temporary makeshifts, to replace a broken focusing screen, are : white tissue paper or tracing paper stretched taut, a fine cambric handkerchief, or plain glass dabbed lightly with putty. For Lohse's method of forming a focusing screen the following is necessary :—

Gelatine . . .	45 grs.	450 g.
Barium chloride .	15 ,,	150 ,,
Ammonium sulphate.	7½ ,,	75 ,,
Water to . . .	3½ oz.	1,000 ccs.

The gelatine, sulphate and three-fourths of the water are heated together until dissolved ; the barium, dissolved in the remaining fourth of the water, is then added. After mixing and cooling, the mass is pressed through muslin so as to form threads, then washed and melted again. Finally a trace of salicylic acid in alcohol is added, the whole is filtered, and is then ready for coating upon plain glass. The solution is slightly troublesome to prepare, but such a screen may with care last a lifetime. A less troublesome method, due to P. R. Salmon, is to apply to plain glass a varnish consisting of—

White lac . . .	70 grs.	80 g.
Picked gum sandarac .	12 ,,	14 ,,
Alcohol . . .	2 oz.	1,000 ccs.

C. Welborne Piper has suggested still another method ; a dry plate should be fogged uniformly all over by immersion in a developer for a long time, fixed, bleached in a solution of 5 grs. of iodine and 10 grs. of potassium iodide in 1 oz. of water, treated with very dilute ammonia, washed, dried, and varnished. A screen prepared in this way, or in any of the other ways above mentioned, is far superior to ground glass.

In process work, the ground-glass screen used has a transparent centre formed by cementing a thin microscopic cover glass to it with Canada balsam. Extremely fine focusing can then be done by means of an eyepiece. A cross should be made on the ground glass with a blacklead pencil before cementing down the glass, so that the focus of the eyepiece may be adjusted to it.

FOCUSING UNCORRECTED LENS

When using an uncorrected lens, that is, one in which the visual and actinic foci are not coincident, an allowance has to be made after focusing so as to bring the sensitive plate into the plane of actinic focus. The amount of this varies with the refractive index of the glass, but as such lenses are commonly made of crown

glass, it is usually safe to place the plate $\frac{1}{50}$ to $\frac{1}{100}$ of the focal length nearer to the lens. The correction may also be made, as in the case of Steinheil's original periscope, by focusing at full aperture and then stopping down to *f*/44, or smaller. Another method is to place a very weak lens in front of the working lens while focusing and removing it before exposure. This corrector must temporarily shorten the focal length to the necessary degree.

FOG (Fr., *Voile ;* Ger., *Schleier*)

A general reduction of the silver salt by the developer, particularly on those places which should be clear glass in the negative or white paper in the print. The various kinds of fog are discussed in later articles.

FOG, AERIAL (Fr., *Voile aérien ;* Ger., *Aetherisch Schleier*)

Mist, or fog, particularly noticeable in the distance in landscapes, due to the reflection of the ultra-violet and blue rays by minute particles of water, vapour and dust. It is a factor to be recognised, particularly in telephotography and mountain work, and in such cases the use of colour-sensitive plates and a yellow screen, which cuts out the ultra-violet and blue, is advantageous. On the other hand, the peculiar softening effect of aerial fog is extremely pleasing from an æsthetic point of view, and care should be exercised therefore not to eliminate its effects unduly.

FOG, CHEMICAL (Fr., *Voile chimique ;* Ger., *Chemischer Schleier*)

A reduction of silver all over the surface of the plate or paper, which may be due either to chemical fog inherent in the emulsion, to too strong a developer, or to the access of actinic light or the use of an unsafe dark-room light. Fog inherent in the emulsion cannot be cured, but its ill effects may be somewhat obviated by exposing fully and adding potassium bromide to the developer. A clean working plate should stand three minutes' development in the dark, without previous exposure to light, in a normal pyro-soda developer, and then present but the slightest trace of deposit. Chemical fog, caused by using too strong a developer, may be obviated by weakening the developer and by the addition of a little bromide.

FOG, COLOUR, DICHROIC, GREEN, AND RED (Fr., *Voile rouge ;* Ger., *Rotschleier*)

A peculiar form of fog, which is green by reflected light and red by transmitted light. It is in all cases due to silver deposited in a colloidal state, and shows itself most prominently in the shadows of a negative. It may be due to the emulsion itself, to traces of "hypo" in the developer, excess of a solvent of the silver haloid, such as sulphite, etc., or it may arise through partial fixation and reduction of the soluble silver salts by traces of the developer. This last form is often to be met with in films when one lies over another in the fixing bath. Dichroic fog is in almost all cases sensitive to light, and though this is not readily noticed, it can be proved at once by covering up part of the negative showing this defect, and exposing to sunlight. It is extremely difficult to remove, but treatment with the following is the most efficacious remedy :—

Sodium sulphite .	1 oz.	50 g.
Potassium cyanide.	100 grs.	10 ,,
Distilled water to .	20 oz.	1,000 ccs.

Abney has suggested bleaching the negative in a mixture of ferric chloride and potassium bromide, well washing, and then redeveloping with ferrous oxalate, which reduces the dichroic to a general fog.

FOGGED DRY PLATES, RESTORING

Plates which have been accidentally exposed to light (lightstruck is a term sometimes used), may be made almost as good as new, with the exception that their speed is reduced, by treatment for about five minutes in either of the following restoring baths :—

Chromic acid . .	15 grs.	6·25 g.
Potassium bromide .	30 ,,	12·5 ,,
Water to . . .	5 oz.	1,000 ccs.
Potassium bichromate	20 grs.	8·3 g.
Hydrochloric acid .	1 drm.	25 ccs.
Water to . . .	5 oz.	1,000 ,,

Afterwards, the plates are thoroughly washed and dried. All the operations must be carried out in the dark-room. Plates that have been exposed in the camera, but have not been developed, may be restored in the same way, but the immersion must be of longer duration. Plates restored in this way need from five to ten times the normal exposure. Several other methods are possible, one of which is to soak the plate in a 2 per cent. solution of ammonium persulphate ; Condy's fluid (as bought), with the addition of a few grains of potassium bromide, also answers. Abney has recommended a bichromate bromide mixture made by dissolving 10 grs. of potassium bichromate in 1 oz. of water, 10 grs. of potassium bromide in another ounce of water, and adding the two together.

Fogged dry plates can be made specially suitable for transparency work by soaking for about ten minutes in—

Potassium bromide .	120 grs.	12 g.
Potassium iodide .	15 ,,	1·5 ,,
Hot water . .	½ oz.	25 ccs.

When dissolved add—

Hydrochloric acid .	½ oz.	25 ccs.
Potassium bichromate	120 grs.	12 g.
Water to . . .	20 oz.	1,000 ccs.

Wash and dry.

The plates are made very slow by any of the processes named, and thus they give greater contrasts ; hence their suitability for copying black-and-white work. They should also be developed with a clean-working developer, such as adurol or hydroquinone.

FOGGED NEGATIVES, TREATMENT OF

The method of treating fogged negatives must depend on the cause or nature of the fog. Development fog, and fogging or staining caused by the plates being stale, are most successfully treated by thiocarbamide. A stock solution

may be prepared, as it will keep well. The formula is :—

Thiocarbamide . .	½ oz.	31 g.
Common alum . .	½ „	31 „
Citric acid . .	¼ „	15 „
Water to . . .	16 „	1,000 ccs.

In very bad cases of fogging, this solution may be used without dilution ; but in ordinary cases one part stock solution to one or two parts of water will be preferable.

Fogging from over-exposure, or from exposing the plate too freely to the dark-room light, is best treated by Farmer's reducer, this consisting of "hypo" and potassium ferricyanide.

Fogging by exposing the plate too much during development or in loading the camera is most difficult to treat successfully. (*See also* "Exposure, Incorrect.")

FOGGED PRINTS, TREATMENT OF

Fogged prints are generally not worth the trouble of treatment, excepting bromide and gaslight paper prints in which the white parts are degraded through the paper being stale. In all other cases the prints should be thrown away and replaced by new ones. The treatment should be the same as that given for plates showing development fog, or fog arising from the plates being stale. (*See* "Fogged Negatives, Treatment of.") The thiocarbamide bath should be used, but the solution should be more dilute. In most cases, 1 part of the stock solution already given should be taken and 3 parts of water added. The thiocarbamide bath should be used after fixing and well washing the print.

FOLDING CAMERA (Fr., *Chambre pliante, Chambre folding ;* Ger., *Falte-kamera, Klapp-kamera*)

Any camera made to close by folding, as opposed to studio and process cameras, which do not close in this way, and to box-form hand cameras. A folding hand camera is commonly understood to be of a specially light and portable construction, although the term is used very indefinitely. A style of hand camera in which the front extends on four struts is known in Germany as a "klapp" camera. (*See also* "Hand Camera.")

FOREGROUND

The part of a subject nearest the spectator. The term is stretched to include water. As foreground objects are naturally seen with the greatest clearness, the treatment of this part of a picture demands careful attention. Especially is this the case with stereoscopic pictures. Foreground objects may be brought into greater prominence if the camera is lowered considerably, especially when (as in the case of a group of flowers) they are intended as the subject of the picture. It is sometimes difficult to get a near foreground and also the distance quite sharp without considerable stopping-down of the lens ; and in such a case the top of the camera back may be swung away from the lens. If there is to be lack of definition anywhere in the picture the foreground is usually the last place where it is permissible.

FOREGROUND SHUTTER (Fr., *Obturateur des devants ;* Ger., *Vortergrund-verschluss*)

A shutter designed to give a longer exposure to the foreground of a landscape, or similar outdoor composition, than to the sky, thus enabling both to receive a more correct exposure than would otherwise be the case.

FOREIGN PLATES, ETC. (For sizes, *see* "Sizes of Plates and Papers.")

FORMALINE, FORMALDEHYDE, FORMIC ALDEHYDE, FORMIC ANHYDRIDE, OR ANTIPYR (Fr., *Formol ;* Ger., *Aldehyde formique, Formalin, Formaldehyd*)

Best known as formaline. Ordinarily it is met with in aqueous solution, which is prepared by passing the vapour of methyl alcohol mixed with air through a heated tube containing copper gauze. The liquid is colourless, has a characteristic smell, and, as obtained commercially, contains about 40 per cent. of formaldehyde. Formaline vapour attacks the mucous membranes of the eyes, nose, and throat, and causes intense irritation.

Photographically, it is used chiefly for hardening gelatine films, it replacing and being safer than alum. A suitable strength is 10 per cent., and it may be used immediately after fixing for both negatives and prints. It has also been suggested as a constituent of developers, the most useful formula being—

Hydroquinone . .	40 grs.	16 g.
Sodium sulphite .	400 „	160 „
Formaline . .	50 drops	20 ccs.
Water to . .	5 oz.	1,000 „

The above is a one-solution developer ready for use, no bromide or alkali being required when formaline is present. The above developer is suitable for negatives of black-and-white drawings, or for giving strong contrasts in other subjects.

FORMIC ACID (Fr., *Acide formique ;* Ger., *Ameisensäure*)

Synonym, hydrogen carboxylic acid. H COOH. Molecular weight, 46. A clear liquid obtained by distilling oxalic acid with glycerine. It is a dangerous caustic, and must be handled very carefully. It was used in the old wet-plate days, and has been recommended as a preservative for pyro, but whilst a good preservative, the addition of an alkali turns the solution muddy and black.

In process work, formic acid is sometimes used instead of acetic acid for the stripping of wet collodion negatives. Its disadvantage is that it is injurious to the hands.

FORMOSULPHITE (Fr., *Formosulfite ;* Ger., *Formosulphite*)

One of Messrs. Lumière's patented products, which takes the place of an alkali in the developer. It is sold in the form of a white crystalline powder, and, as its name suggests, is a preparation of paraformaldehyde, sodium sulphite, and a small quantity of an alkaline bromide. It acts also as a preservative, prevents stain, and hardens the film.

FORMYL CHLORIDE OR TRICHLORIDE (*See* "Chloroform.")

FOTHERGILL PROCESS (Fr., *Procédé Fothergill;* Ger., *Fothergill's Prozess*)

A dry process introduced by Thomas Fothergill in 1858. The plate having been collodionised and sensitised in a neutral silver nitrate bath, as usual in the wet-plate process, was washed with rain water and allowed to drain for about half a minute. Some plain albumen, obtained by well beating the white of 1 egg with 2 drms. of water, and allowing to subside, was then poured on the collodion film, and, after remaining for thirty seconds, was washed off under a gentle stream of rain water, sufficient remaining in the pores of the collodion to answer the purpose of preserving its sensitiveness. The plate was then allowed to dry and was fit for use. Such plates would keep some time, and could be exposed dry without previous preparation.

FRAME (Fr., *Cadre;* Ger., *Rahmen*)

The selection of a suitable frame for a finished print is an important matter. Fortunately, the special demands of photographers in this respect have been fully met, and there is now no lack of choice in appropriate frames. It must be remembered that the chief purpose of a frame, with or without a mount, is to isolate the picture from its surroundings. Therefore, a frame defeats its own end when it attracts attention from the print to itself. For this reason an ornate, or so-called "fancy" frame, is generally unsuitable. The great majority of photographic prints are seen to best advantage in a simply designed frame of a dark colour. The various mouldings may be roughly classified into those that are flat and practically flush with the picture, those that throw it forward, and those that throw it back. If the print is framed close up, that is, without showing any margin, a wide moulding is generally best. A narrow one in such a case does not adequately isolate the print, and has a "skimpy" effect. On the other hand, a mounted print demands a much narrower moulding. The more mount there is the narrower may the moulding be, as the mount and frame may be regarded as a whole.

Gold frames, and those with a highly varnished surface, are not often suitable. Far more effective, as a rule, are well-made frames of good solid oak, stained brown or black, and polished by friction with a brush or a rough cloth, or by the sparing application of beeswax and turpentine. (*See also* "Framing.")

FRAMES, PRINTING (*See* "Printing Frames.")

FRAMING

In addition to the actual selection of a suitable frame for a photograph (*see* "Frame"), there are one or two other points to take into account. First comes the question of the glass. This should not only be free from flaws and waviness, but it should be as colourless as possible. If a sheet of the usual picture-framer's glass be laid down, so as to cover half of the print only, a great difference will be noted between the covered and uncovered halves. Not only is the colour of the print affected, but there is a marked alteration in the values. Generally the tones are degraded or flattened, especially in the case of delicate grey prints. When a clearer glass cannot be used, the print should be kept somewhat brighter than it is intended to appear in its framed state. When the glass is placed in the frame it is well to run a narrow fillet of paper round the edge, pasting it down to the glass and the sides of the rebate. Take care that it does not show from the front, its object being merely to keep out dust. The backboard having been bradded securely down, glue or paste brown paper over the entire back.

FRAUNHOFER LINES

When a solar spectrum is viewed in a spectroscope with a very narrow slit it will be seen to be crossed by thousands of transverse dark lines. The most prominent of these were named by Fraunhofer according to the letters of the alphabet, and are now called by his name. No matter what the dispersing medium may be, prism or grating, these lines always fall in exactly the same colour; they are therefore extremely convenient "milestones" or data for naming any colour, and enable one to define a colour exactly. For instance, the term "yellowish green" conveys no strictly definite idea; whereas the term "a yellowish green like D ½ E"—that is, midway between the Fraunhofer lines D and E—indicates a definite and fixed tint. The cause of Fraunhofer lines was determined by Kirchoff and Bunsen, who discovered that any substance in a state of incandescent vapour absorbed exactly those rays which it emitted when in a state of luminescence. For example, if a pellet of metallic sodium is burnt in an electric arc it emits two dazzling orange-yellow rays, known generally as the D lines; but if the light thus emitted is allowed to pass through a cloud of somewhat cooler sodium vapour these brilliant yellow lines instantly become black—that is to say, their light is absorbed. This fundamental law applies to all substances, and by its aid it has been possible to detect the elements burning in the sun and in still more distant stars. (*See also* "Spectrum.")

FREEZING OR COOLING MIXTURE (Fr., *Mélange réfrigérant;* Ger., *Kältemischung*)

A mixture which, by absorption of heat in liquefying, produces a low temperature. It is largely used in hot countries, and sometimes in England during hot weather, to cool solutions, particularly for use with gelatine plates and papers. The ordinary "hypo" fixing bath is itself a cooling mixture, for when freshly mixed the temperature of the water falls considerably. The most common freezing mixtures are the following:—

	Proportions by Weight	*Temperature Produced*	
Snow or pounded ice	2	−4° F.	−18° C.
Common salt (sodium chloride)	1		
Snow	3	−54° F.	−48° C.
Crystallised calcium chloride	4		
Water	1	5° F.	−15° C.
Ammonium Nitrate	1		
Water	1	1·4° F.	−17° C.
Sodium sulphate	8		
Hydrochloric acid	5		

A good method of lowering the temperature of solutions is to place the bottles containing them in a freshly made "hypo" bath.

FRENCH CHALK (*See* "Chalk, French.")

FRILLING

A trouble to which negatives are liable while undergoing treatment in the various solutions; the edges of the gelatine film leave the glass plate and are cockled. It is due to the uneven temperature of the solutions, excess of soda or other alkali in the developer, handling the negatives with the warm fingers, the use of strong fixing solutions, or to rapid washing, the water being allowed to impinge upon the edges of the plates in such a way as to lift the films. Frilling may be prevented by hardening the film before or after development with formaline, or a combined fixing and hardening bath may be used. If no precautions are taken and the gelatine is found to be frilled, it may be more or less remedied by treating with methylated spirit. Frilling is allied to the far more common defect of blistering, and the remedies given under a separate heading for the latter apply equally well for the former. Frilling often appears on print-out papers when they are torn, as, for example, when a half-plate piece is torn into halves for use as quarter-plates. Printing papers should always be cut clean, because rough edges allow the water to get easily under the films, so causing frilling.

Two old-fashioned but serviceable methods of preventing plates from frilling may be mentioned. One is to soak the dry plate before development in a saturated solution of Epsom salts, and the other is to rub a wax or tallow candle round the exposed dry plate on the film side, before wetting it with the developer. Neither of these, however, is as reliable as immersion in a 10 per cent. solution of formaline. (*See also* "Hardeners" and "Blisters.")

FRONT, CAMERA (Fr., *Planchette d'objectif*; Ger., *Objektivbrett*)

That part of the camera which carries the lens. It should be provided with a rising and falling movement, and a cross movement is an additional advantage. In field cameras, it should preferably also be arranged to swing, in order that the lens may be tilted if desired without needing to incline the camera. The fronts of large cameras are commonly furnished with a removable panel for the lens, an arrangement which, by the employment of several panels, permits various lenses of different sizes or foci to be used interchangeably on the same camera. (*See also* "Cross Front," "Detachable Front," "Rising Front," and "Swing Front.")

FROST SCENES

The photographing of frost scenes is dealt with under the heading "Snow and Hoar Frost Photography." Frost on window-panes may be successfully photographed by placing a black cloth outside the window at an angle of 45° and photographing the frost from the inner side.

F.R.P.S.

Fellow of the Royal Photographic Society. The Fellowship was instituted January 1, 1895, and is open to those who, being already members, satisfy the Council of their ability in, or contributions to, any branch of photographic work, an annual subscription of two guineas being payable.

FULL APERTURE

When no stop is used, a lens is said to work at "open aperture" or "full aperture."

FULMINATING COTTON

Another name for gun-cotton (*which see*). Sometimes used in flashlight photography.

FUMING

Photographically, the exposing of albumen paper to the fumes of ammonia; paper so treated gives brighter prints and tones to richer colours more easily. The sensitive paper to be fumed is pinned to the inner side of a box lid; in the bottom of the box is placed liquor ammoniæ in a saucer, or it is sprinkled upon blotting-paper. The box is then closed, and the paper exposed (in the dark, of course) to the action of the ammonia fumes for about ten minutes, or longer if the weather is cold. Fuming is now almost obsolete, but at one time it was recommended for papers other than albumen, and even for plates.

FURNELL'S DEVELOPER

A developer widely advocated about 1890 for positive work; it is claimed to keep for years, allow great latitude in exposure, give clear glass shadows, and not frill the film.

No 1:—

Sodium sulphite	50 grs.	10 g.
Powdered alum	10 „	2 „
Distilled water	3 oz.	250 ccs.

Dissolve, filter, and then add—

Pyro	24 grs.	4·8 g.
Sodium nitrate	36 „	7·7 „

This is made up as a stock solution, and it will keep indefinitely.

No. 2:—

Liquor ammoniæ (·880)	1½ drms.	15 ccs.
Ammonium bromide	30 grs.	6 g.
Distilled water to	15 drms.	150 ccs.

To develop, take ½ oz. of the No. 1 (pyro) solution, made up to 2 oz. with water, and add 10 drops of the No. 2 (ammonia) solution, and apply to the plate, adding more of the latter if necessary. After development, do not wash but rinse in a saturated solution of alum, then wash and fix in the following bath, after which wash and dry:—

Sodium hyposulphite	2 oz.	220 g.
Sodium carbonate	½ „	55 „
Alum (saturated sol.)	½ „	50 ccs.
Water to	10 „	1,000 „

G

γ (*See* "Gamma.")

GAEDICKE'S INTENSIFIER

One of the silver intensifiers, the formula being :—

Ammon. sulphocyanide	100 grs.	46 g.
Silver nitrate . .	48 ,,	22 ,,
Sodium sulphite .	500 ,,	230 ,,
"Hypo" . .	100 ,,	46 ,,
Potassium bromide	7 ,,	3 ,,
Water . . .	5 oz.	1,000 ccs.

To prepare for use, mix as follows :—

Stock solution as above	48 drops	100 ccs.
Water to . . .	1 oz.	1,000 ,,

Then add—

Rodinal . . .	16 drops	33 ccs.

Immerse the negative therein until intensified and then wash.

GALL (*See* "Ox-gall.")

GALLATE OF IRON PROCESS

Better known as the "Ink Process" (*which see*). The term has been loosely applied to other iron processes of printing.

GALLIC ACID (Fr., *Acide gallique;* Ger., *Gallischsäure*)

Occurs in fine, silky, yellowish crystalline needles. C_6H_2 $(OH)_3$ COOH H_2O. Solubility 1 per cent. in cold water, 33 per cent. in boiling water. Largely used in the early days of photography as a developer for paper negatives, and it was with this acid that Talbot in 1835 made some important discoveries in connection with the latent image. It is occasionally used in modern processes, as, for example, in the development of P.O.P., intensification of collodion and gelatine plates, and as an ingredient in the ferrous citrate developer for chloride plates.

Gallic acid is often used by lithographers for preparing the surface of zinc plates for printing, instead of the nutgall decoction recommended by the old workers; the effect is the same, and the trouble of preparing the decoction is saved.

GALLO-NITRATE OF SILVER PROCESS

Another name for the old calotype or talbotype paper process, in which paper was sensitised with silver nitrate, immersed in potassium iodide, washed, dried, exposed, and developed with a mixture of silver nitrate, gallic, and acetic acids and water. (*See* "Calotype.")

GALLS (NUTGALLS)

In zincography—lithographic printing from zinc plates—a decoction of nutgalls, mixed with gum arabic solution, is used for preparing the bare parts of the zinc so that they repel the greasy printing ink used for rolling-up. To make the decoction, steep 4 oz. of nutgalls in 3 quarts of water for twenty-four hours, and then boil up and strain. For use, add ¾ pint of this solution to ¼ pint of gum solution, of the thickness of cream, and 3 drams of a solution of phosphoric acid.

GALVANOGRAPHY

Under this name there have been put forward several processes based on the idea of painting on a silvered copper plate with oil colour in thick masses so as to give relief. When dry, or nearly so, the surface is dusted with finely powdered blacklead to make it electro-conductive, and a thick copper shell is deposited on it. This is subsequently used as an intaglio printing plate. A process of this kind was patented by Prof. Herkomer and Henry T. Cox in 1898. The basis of the method was described by Franz von Kobell, of Munich, as early as 1842.

GALVANOGRAPHY, PHOTOGRAPHIC

A process of utilising a gelatine relief as a mould for making electrotypes. Several inventors have adopted the title, but Paul Pretsch had probably the best right to it. His process consists in coating a glass plate with gelatine containing bichromate, with a silver salt and other chemicals. When dry it is exposed under a transparency, and then immersed in cold water to dissolve out the unaltered chromium salts and cause those parts protected from the light to swell up in proportion to the tones of the picture. The high lights do not swell at all, and have no grain. The plate thus produced is, of course, an exact reverse of that required for printing. The surface is next made conductive with a metallic coating, so that an electrodeposit can be made upon it, thus producing a copper shell which can be backed up with type metal to form a printing plate.

GAMBOGE (Fr., *Gomme gutte;* Ger., *Gummigutt*)

Synonyms, camboge, gummi gutte. A gum resin obtained from several species of guttiferæ trees, occurring in bright orange lumps with conchoidal fracture; used as a colouring pigment.

The coating of lithographic writing transfer paper is coloured with gamboge in order that the prepared side may be distinguished from the unprepared one. Gamboge has been recommended as an addition to Indian ink for drawings intended for photo-reproduction.

GAMMA (Fr. and Ger., *Gamma*)

The term adopted by Hurter and Driffield to define the gradation, or degree of contrast, of a

negative. Gamma infinity, or $\gamma\infty$, as it is usually written, is the ultimate density-giving power of the plate. (*See* "Plate Testing.")

GAS CYLINDERS

(*See* "Cylinders, Gas.")

GASLIGHT PAPERS

Papers coated with a chloride or chloro-bromide emulsion, which can be manipulated in weak gaslight. For suitable emulsions, *see* under the heading "Emulsions for Development." Gaslight paper (so called) is really a very slow bromide paper, and is developed, fixed and toned (if necessary) like bromide paper, except that the developer must be stronger, and the development is more rapid. Exposure can be made by putting the paper into contact with a negative which is held a few inches from a gas burner or good oil lamp, but development must not take place in a light equally strong or the print will be fogged; either the light must be turned down during development, or the operation must be carried out at some distance from the light or in a shadow. Artificial lights other than gaslight, or even very weak daylight, will serve equally well; in fact, the common practice is to expose to the light of magnesium ribbon and develop by aid of weak artificial light. A metol-hydroquinone developer is usual, and this must be accurately prepared, particularly as regards the potassium bromide; too little bromide causes impure whites, while with too much the blacks will be of a greenish hue. Development should take place almost instantaneously. An acid fixing-bath is advisable, but not necessary. The colour of the print depends on exposure and development; longer exposure and a weaker developer invariably produce warmer tones. With most papers a warm brown tone may be obtained by giving three times the normal exposure and diluting the developer with twice the bulk of water.

GASLIGHT, PORTRAITURE BY

The use of gaslight is possible for portraiture. With ordinary gaslight (without mantles), exposures are long even under the most favourable conditions, the light being poor in violet rays and comparatively non-actinic. Gaslight has advantages for isochromatic work, as without a yellow screen it gives practically the same result as daylight with a screen, isochromatic plates being used in both cases. With a very rapid plate, and the lens stopped down to *f*/8, the necessary exposure with two gaslights (not incandescent) 3 ft. from the sitter would be about two minutes. Particular care is necessary in posing, using a reflector, and in development, as the results are bound to be a trifle hard and "contrasty."

Incandescent gaslight is better for portraiture, as a full-size mantle gives an illumination of about sixty candle-power when at its best, and is about one and a-half times as effective photographically as a gas flame of the same visual intensity, because of the whiteness of the light and its richness in the blue or actinic rays. The exposure depends, of course, upon the number of burners. The special fittings obtainable from factors are in the form of brackets containing a score or more lights, which make possible quite brief exposures—say one or two seconds; but an enormous amount of heat is produced. Fair results may be obtained with one or more ordinary domestic burners, but the exposure is somewhat long, a minute at least, with two lights near to the sitter, a very rapid plate, and the lens at *f*/8.

It will be noted that *all* gaslights are incandescent, the light in a plain flame being produced by heating particles of carbon to incandescence; but it is convenient to adopt here the ordinary nomenclature by which the term "incandescent" is restricted to burners of the Bunsen type, fitted with mantles of rare earths.

Acetylene outfits for portraiture are similar to the incandescent gas fittings in arrangement. The light is very actinic, and as a rough guide it may be said that when using fourteen acetylene lights, a rapid plate, and a lens at *f*/8, an exposure of about five seconds is required in an ordinary room; the distance of the lights from the sitter greatly affects the length of the exposure. (*See also* "Artificial Light, Photography by.")

GAUGE, PRESSURE

The lanternist ascertains the contents of gas cylinders by means of a gauge. He may know that the cylinder is of 20 cubic feet capacity, and the full cylinder gives a gauge pressure of 120 atmospheres; after the exhibition, the gauge may indicate, say, 50 atmospheres. Then the content equals $\frac{50}{120} \times 20 = \frac{50}{6} = 8\frac{1}{3}$ cubic feet.

A pressure gauge is used on the motor aerograph pump, the degree of pressure being indicated in pounds per square inch on a circular dial. With the aerograph foot pump a simple form of pressure gauge is used, consisting of a U-shaped tube filled with a coloured fluid, one end being closed and the other attached to the air reservoir. As the pressure varies it is indicated by marks on a scale placed behind the tube.

On the large vacuum and pneumatic frames used by process workers there is generally a pressure gauge, reading in pounds per square inch on a circular dial.

The Levy acid-blast etching machine has a gauge consisting of a column of mercury in a glass tube, communicating with a U-tube in the iron casting of the gauge. As the pressure increases or decreases the mercury rises or falls, and the pressure in pounds per square inch is read on a scale alongside the glass tube.

GAUSS POINTS

(*See* "Nodal Points.")

GELACOL

A preparation of gelatine treated with acetic acid to destroy its setting property. It is used for coating glass plates with a substratum, particularly in collodion emulsion work.

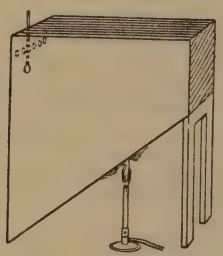
GELATINE

(Fr., *Gélatine;* Ger., *Gallerte, Gelatin*)

A colloid of extremely complex nature, containing carbon, hydrogen, nitrogen, and oxygen, with a small proportion of sulphur. It is known commercially in fine shreds or thin, flat sheets, marked with the diamond pattern of the strings

on which it is dried. Photographic gelatine is usually prepared from selected hides, whereas inferior sorts are prepared from bones, tendons, and cartilages. It is insoluble in cold water, which it absorbs and then swells up to a slimy mass; it is soluble in all proportions in hot water, but insoluble in alcohol and ether. The principal constituents are two substances known as glutine and chondrine; the former is not precipitated by the alums, whilst the latter is, and gelatines rich in chondrine are the best for photographic purposes. A simple test for this is to add to a warm 10 per cent. solution of gelatine an equal volume of a saturated solution of chrome alum, when the solution should instantly set to a jelly. It is only possible to indicate the general characteristics of a gelatine suitable for photographic purposes, as the true test of its suitability is to make a practical trial with a small batch of emulsion. A good gelatine should absorb not less than six times its weight of water, and not much more than twelve or fifteen times.

There are three kinds of photographic gelatine: hard, medium or middle hard, and soft. Hard gelatines should not melt below 82° F.



Device for Determining Melting Point of Gelatine

(nearly 28° C.); if they do not melt at 88° F. (31° C.), there is a risk of their having been hardened with alum. Soft gelatines should melt at from 62° to 75° F. (say 17° to 24° C.). A 1 per cent. solution should set to a jelly when cooled down to 56° F. (13·3° C.), and remain without any sign of putrefaction for twenty-four hours.

The determination of the melting point is somewhat difficult, and Child Bayley has suggested an excellent practical device here shown in the testing position. This may be made of copper or zinc, and the sloping portion is to prevent heat from the Bunsen burner passing direct to the front of the tank. Across the front of the tank should be scratched a line about 1 in. from the top, and on this line should be placed some discs of gelatine. Gummed labels are cut into strips about $\frac{1}{2}$ in. wide and about $1\frac{1}{2}$ in. long, and their ends are then gummed together, with the gummed surface outside, so as to form rings. The tank should be placed with the front and marked surface up, and the paper rings placed on the line and then carefully filled by means of a pipette with a warm 10 per cent. solution of gelatine. When the gelatine is thoroughly set, the rings should be cut down with a sharp knife and stripped off, and the tank set upright and filled with cold water, and this heated by means of the Bunsen burner. The discs must be carefully watched, and when they begin to melt and run down over the line the temperature should be noted. A mean of six trials may be taken as correct.

Another method is to use a thermometer in a very narrow test tube, just 1 mm. ($\frac{1}{25}$ in.) wider all round than the thermometer bulb, which should be of elongated shape. Then fill the tube with the gelatine solution and, while hot, immerse the thermometer well into the tube, and set. Afterwards place the tube in warm water, and gradually raise the temperature; then when the gelatine melts, the tube will drop off, and the temperature can be noted.

Gelatine is used for preparing baryta paper, for emulsions, both negative and positive, in collotype, photogravure, and other photo-mechanical processes, and it is the chief ingredient of an excellent mountant.

Solutions of sulphocyanides and barium chloride dissolve gelatine in the cold, as do also acetic, oxalic, hydrochloric, and sulphuric acids. Zinc chloride and chloral hydrate destroy its setting power. The setting is increased by the alums, magnesium sulphate, and numerous other salts. It forms a compound, gelatinate of silver, which is sensitive to light, with silver nitrate.

In process work, gelatine has numerous uses —namely, for coating collotype plates, for preparing photo-lithographic paper, for the carbon tissue in the photogravure process, for the making of gelatine reliefs, for use as a substratum on glass plates, for the making of films for shading mediums, for making litho-transfer papers and films for tracing, for stripping negative films, for making colour filters, for glazing prints, etc. Particulars of these applications and uses are given under the respective subject headings.

GELATINE, BICHROMATED

Gelatine treated with an alkaline bichromate forms the basis of the carbon process and of all photo-mechanical printing methods. Fish-glue is employed in some processes, but that is a substance closely allied to gelatine; and other colloids are sometimes substituted, as in the gum-bichromate process. Gelatine, in its normal condition, will absorb cold water readily, and dissolve easily in hot water. Gelatine treated with an alkaline bichromate retains these qualities if kept in the dark; but if exposed to light, it no longer absorbs cold water, or swells in consequence, and it also becomes insoluble. These properties are utilised in different printing methods. In the carbon process, and in some photo-mechanical methods, an image in gelatine is produced by exposing a film of bichromated gelatine under a negative, and then dissolving away those parts on which the light has not acted by means of hot water. In others, a gelatine relief is produced by means of the unequal swelling of a gelatine film that has been exposed under a negative when soaked in water. Details of the various processes in which these qualities are utilised are given under their respective headings.

In process work, many processes depend on the properties of bichromated gelatine. Among these may be mentioned collotype, photogravure,

photo-lithography, and photo-relief. For the half-tone process gelatine has not been found so satisfactory as fish-glue, the latter having no setting property, and being easily developed with cold water. An attempt was made of late to utilise for half-tone a gelatine in which the setting property had been destroyed, but it was found to be more subject than fish-glue to changes of temperature, and also liable to become putrid very readily.

GELATINE EMULSIONS (*See* "Emulsion.")

GELATINE MOUNTANTS (*See* "Mountants.")

GELATINE PAPERS

Printing papers which are coated with gelatine, which acts as a vehicle for the silver salts. All bromide and gaslight papers, and most makes of ordinary P.O.P., are gelatine papers. Some makes of P.O.P. are coated with collodion. Nearly all self-toning papers have collodion emulsions, but a few have gelatine. Gelatine papers are sticky when wet, and the emulsions dissolve in hot water.

GELATINE PLATES AND FILMS

Glass plates or celluloid coated with gelatine emulsions, as distinguished from collodion plates.

GELATINE RELIEFS

Probably more ingenuity has been displayed in devising processes for making gelatine reliefs to serve as printing surfaces than in any other form of photo-mechanical work, and yet there is not one of these processes that is in regular commercial use at the present day. These processes date from the experiments of Fox Talbot and Poitevin. In general the basis of the process is the preparation of a thick film of bichromated gelatine on plate glass, exposing it under a negative or positive when dry, and developing with warm water so that the unexposed parts wash away, leaving those portions standing that have been acted upon by light. The relief is hardened with alum or other agents, and dried. (This is the "Wash-out Gelatine Process," *which see.*) In some processes, however, the unaltered gelatine is not washed away, but is allowed to swell up, and thus form a matrix for casting in plaster. (*See* "Swelled Gelatine Process.")

The foregoing were chiefly used for line reproduction processes, but others are intended for making half-tone reliefs. Dallastype and Dallastint, and Pretsch's photo-galvanography are processes of the kind that are described under separate headings; and Woodbury also devised a process of this nature for typographic printing. The half-tone image is either formed by printing through a screen, or by reticulating the surface of the gelatine. In Woodburytype (*which see*) the gelatine relief is utilised, but in an essentially different manner from the foregoing; pigment is introduced into the film, and development is similar to that of carbon tissue. Stannotype is a variation of Woodburytype. Photo-filigrane (*see* "Filigrane") is another process depending on a gelatine relief. (*See also* "Acrograph," "Leimtype," "Mosstype," "Stannotype," etc.)

GELATINEGRAVURE

Transparent gelatine is placed over a photograph, and a drawing made by scratching. When this is complete the lines are filled with lithographic transfer ink thinned with turpentine and applied with a dabber. Printing is done by running the gelatine through a roller press in contact with paper.

GELATINO-BROMIDE PAPERS AND PLATES

Papers or glass plates coated with gelatino-bromide emulsions.

GELATINO-BROMIDE PROCESS (Fr., *Gélatino-bromure;* Ger., *Bromsilbergelatin*)

A term used in the early days of dry-plate photography to distinguish the method of manufacture of the emulsion from collodion It is now also used to include bromo-iodide plates.

GELATINO-CHLORIDE PAPER

Paper coated with an emulsion of silver chloride in gelatine.

GENRE WORK

The word "genre" comes through the French from the Latin "genus," a kind. In painting it has been used to signify figure subjects of a homely or domestic character, generally engaged in their ordinary occupations. The term has been adopted to signify the same subjects treated photographically. Similar considerations apply as in dealing with single figures and groups. There are the same difficulties of securing satisfactory pose and arrangement, and a suggestion of natural action. The "setting" of the figures and the choice and arrangement of the accessories also play an important part. Careful studio arrangements and the employment of good models have frequently led to the production of excellent genre pictures, but the best and easiest way is to study and treat the real subjects and their ordinary surroundings both in and out of doors. The works of some of the painters of the Dutch school offer very fine examples of the effective treatment of genre subjects. The thing to aim at is harmony and unity. (*See also* "Figure Studies.")

GEOLOGICAL PHOTOGRAPHY

Photography as applied to geological investigation may be roughly classed under the following headings: (1) Photographs showing plains, valleys, escarpments, base levels, mountains, lakes, rivers, glaciers, etc., taken for the purpose of illustrating the origin of landscape, and the action of atmospheric and other processes of denudation. (2) Photographs of the faces of cliffs, quarries, railway cuttings, and other exposed surfaces, to show the way in which strata have been laid down, and changes which have taken place producing unconformity, overfolding, faults, dip and strike, anticline and syncline, crushing, cleavage, and joints. (3) Photographs of fossil remains, both *in situ* and after cleaning, to show the types of animal and plant life existing during the formation of the strata in which their fossil remains are embedded. (4) Photo-micrographs of thin sections of rocks, showing their structure, composition, and any

minute animal and plant remains that may be present.

For most geological photography, a good stand camera, having a long extension of bellows, swing back, and rising front, will be found most serviceable. A good lens is all-important, as the value of a geological photograph depends upon its perfect clearness and sharpness of detail. The lens should be provided with a deep hood for use in the field, which will prevent flare, and flat, foggy-looking negatives, caused by reflections and rays of light falling obliquely on the front surface of the lens. The tripod should be substantial and rigid, so that there will be no fear of vibration during exposure, for it is always best to stop down the lens and give a full-time exposure, so that a crisp, sharp negative, full of detail and gradation, may be obtained. It is often desirable when photographing a portion of the face of a cliff, or part of the strata laid bare in a quarry or railway cutting, to include in the photograph some familiar object of which the size is well known, to act as a kind of rough scale by which one may judge the relative thickness of a deposit, or the size of a fossil seen *in situ*. For this purpose, some workers use their geological hammer, but as hammers vary a good deal in size and shape, it is much better to include a twelve-inch or two-foot rule. Orthochromatic plates should always be used. F. M-D.

GERMEUIL-BONNAUD (*See* "Dusting-on (Powder) Process.")

GHOST IMAGES IN LENSES (*See* "False Images, or 'Ghosts.'")

GHOST PHOTOGRAPHY (*See* "Psychic Photography.")

GIFFORD'S SCREEN

A so-called monochromatic light screen, made by immersing a slip of cathedral green glass, which is of bluish green tint, in a solution of aniline green. It is used in photo-micrographic work, and passes a spectral band about E in the green.

GIGANTOGRAPHY

A process of making enlarged half-tone negatives for poster printing. Two cameras are required—one a small one, according to the size of the original image, and the other large enough to take the enlarged negative. The lens of the small camera is connected to an aperture in the front of the large camera, on the principle of the usual enlarging camera. An evenly graded transparency, thin but full of detail, is placed in the dark-slide of the small camera, the shutters drawn out, and the slide placed in position. The half-tone screen is placed in its holder in front of the positive, and the distance of the screen is set proportionately to the extension of the camera to secure the desired enlargement. A powerful light is reflected through the positive by illuminating with arc lamps a sheet of white paper placed behind it. The image is then focused, and the ruled screen adjusted until the desired dot image is obtained. The advantage of the process is that it saves the necessity of a very large and expensive ruled screen.

GILLOTAGE

The earliest process of line zinc etching, invented by Charles Gillot, of Paris, and patented in France in 1850; known as panikonography, or the French or Parisian method of zinc etching. The principle of the method is that an image in lithographic ink on zinc is strengthened for acid resisting by repeatedly rolling up with ink and then dusting with resin, the plate being heated to melt the resin, so that it runs down the sides of the lines and protects them against undercutting by the acid.

"GIPHANTIE"

A book written in 1760 by a Frenchman, Tiphaigne de la Roche, the title being an anagram of his own name. It contains a forecast of photography. One paragraph says: "You know that the rays of light reflected from different bodies form pictures, paint the image reflected on all polished surfaces, for example, on the retina of the eye, on water, and on glass. The spirits have sought to fix these fleeting images; they have made a subtle matter by means of which a picture can be formed in the twinkling of an eye. They coat a piece of canvas with this matter, and place it in front of the object to be taken. The first effect of this cloth is similar to that of a mirror, but by means of its viscous nature the prepared canvas, as is not the case with the mirror, retains a facsimile of the image. The mirror reflects images faithfully, but retains none; our canvas reflects them no less faithfully, but retains them all. This impression of the image is instantaneous. The canvas is then removed and deposited in a dark place. An hour later the impression is dry, and you have a picture the more precious in that no art can imitate its truthfulness." A still earlier writer, Fénélon, had a vision of photography, but did not so clearly express it; his book bears the title of "Un Voyage Supposé," and was written in 1690.

GISALDRUCK

A photo-lithographic process, invented by B. Gisevius, of Berlin, for direct printing on aluminium without a negative. The actual drawing is printed through on to a sensitive film on the metal, and the negative image is converted into a positive. It resembles the Vandyke process (*which see*).

GLACIAL ACETIC ACID (*See* "Acetic Acid.")

GLAISHER, JAMES

Born in London, April, 1809; died at Croydon, February 7, 1903. Was for twenty-three years (1869 to 1874 and 1875 to 1892) president of the (now) Royal Photographic Society. He was largely responsible for the photographic recording instruments in Greenwich Observatory.

GLASS (Fr., *Glace, Verre;* Ger., *Glas*)

Ordinary glass is a fused mixture of silicates of calcium or lead with the silicates of sodium or potassium. While practically unaffected by acids, except hydrofluoric, it is attacked by strong alkalis, which dissolve out the silica. Some glasses are yellowed by prolonged exposure to light; this is frequently the case with old lenses.

Crown Glass is made usually from sand, lime, and a sodium salt, with sometimes lead oxide.

Flint Glass contains potassium carbonate, red lead, sand, and saltpetre. It is easily fusible, and is not so suitable for chemical purposes, for which a soda-lime or potash-lime glass is preferable.

Opal Glass is obtained by fusing an oxide of tin or zinc with the pot-metal; a "flashed" opal, consisting of a thin opal layer united to plain glass, is also manufactured.

Optical Glass first received specific attention from Pierre Louis Guinand, of Les Brenets, in Switzerland (born 1748, died 1824), who obtained improved results by stirring the fused mixture with a rod of crucible clay. J. Fraunhofer (born 1787, died 1826) succeeded in avoiding striæ and in procuring glass of a uniform refractive index by the simple expedient of using larger pots for melting; he also investigated some of the optical effects resulting from variations in the ingredients and their proportions. In 1842 a son of Guinand introduced boracic acid into the glass, which, however, did not then meet with favour. In 1851 Maes, of Clichy, produced a colourless and homogeneous zinc crown glass, containing zinc oxide and boracic acid; this was used in Charles Chevalier's photographic objectives. L. Seidel in 1856, and J. Petzval in 1857, pointed out that new glasses, having a different relation between their refractive and dispersive powers to those then in use, were required for the perfection of the photographic objective, but it was not till Otto Schott and E. Abbé began their joint work in 1881 that any real progress was made. In 1886 the famous Jena works were started by Schott, Abbé, and R. Zeiss, under a liberal subvention from the Prussian Government. Since then the production of optical glass of almost any required refractive or dispersive power has been rendered possible by the use of new chemical ingredients.

People often talk loosely of the Jena optical glass, as if there were only one variety, although, as a matter of fact, several hundreds of different varieties of optical glass are known, these including all the ordinary flints and crowns, besides the special glasses that have made the manufacture of the modern anastigmats possible; it is these special glasses that are generally meant by the term "Jena glass." With the older makes of optical glass, increased refractive power was always accompanied by a high degree of dispersion, but in the new Jena glasses a very high refractive power is obtained with a comparatively low dispersion.

(For the optical properties of glass, *see* "Lens.")

Cements for Glass.—A cement for glass needs to be as colourless as possible, the best from this point of view being Canada balsam, which should be dried in an oven, allowed to cool, the glass gently heated, the remelted balsam thinly applied, and the surfaces brought together. This is the universal cement for lenses. Other excellent cements (but not suitable for lenses) are water-glass, which, however, tends to roughen the glass, and an emulsion of gelatine in sufficient acetic acid to cover it, the process of digestion being assisted by standing the bottle in warm water.

In process work, glass is an important material. To secure good contact between the negative and metal plate in direct printing, the glass must be flat, and plate glass is preferable, though for the general run of work a good selected sheet glass is used. Plate glass of about ¼ in. thickness is used for assembling a number of stripped films on to one plate. For process printing-frames, thick plate glass is used up to 1¼ in. thickness in the largest frames, and this glass must be well annealed in order to withstand the strain of the pressure and the heat of the arc lamps used for printing. The glass must also be free from surface scratches and other imperfections which would show in the print.

GLASS, CLEANING

Glass for photographic purposes must be scrupulously clean. Glass upon which prints are squeegeed for glazing is best cleaned by soaking in very dilute nitric acid and scrubbing with soap and water; after drying, it is dusted over with French chalk and polished. When glasses are to be used for coating and sensitising, as in the wet collodion process, rouge or whitening or fine tripoli powder mixed with methylated spirit to the consistency of thick cream is recommended; the paste is rubbed over the glass, rinsed off with water, and a final polish is given with chamois-leather.

A good mixture for thoroughly cleaning glass for ordinary purposes is—

Soft or rain-water . .	1 part
Powdered pumice stone .	1 ,,
Chalk or whitening . .	1½ ,,
Liquor ammoniæ . . .	½ ,,

Apply with a piece of flannel, and polish with a soft rag, chamois-leather, or soft paper crumpled up.

To clean films off old negatives, soak in hot soda-water for a few minutes, and scrub with a brush; or, if they are not varnished, soak them for an hour or two in water made slightly acid with nitric acid; the films can then be rubbed off with a strip of wood, or placed in hot soda water and scrubbed. When the negatives have been varnished, it is necessary to use a strong and hot solution of common washing soda or caustic potash, and leave the negatives in this until cold, when the films will leave the glass. Do not let the caustic potash solution touch the fingers.

In process work, in which collodion and collodion emulsion are used so largely, it is necessary to take great pains in cleaning glass. New glass is best soaked in a 5 per cent. solution of hydrochloric acid contained in grooved lead-lined troughs; and it is then rinsed with plenty of water and polished with methylated spirit 20 oz., tripoli 10 oz., iodine 2 drams. Prepared chalk or whiting may be used instead of tripoli, and equal parts of methylated alcohol and ammonia instead of iodine.

For removing collodion films from old negatives, nitric acid is generally used in the proportion of 1 oz. acid to 6 oz. water. A good film-removing pickle, free from fumes, consists of—

Sulphuric acid . .	4 oz.	200 ccs.
Potassium bichromate .	4 ,,	220 g.
Water	20 ,,	1,000 ccs.

After treatment, swill and put in the draining-rack. Next, with a linen rag charged with whiting of the consistency of thick cream, rub well both sides of the partially dry negative glasses; then put into a clean bath composed of nitric acid 4 oz., water 40 oz. Finally, swill under a tap and then albumenise.

GLASS, ETCHING ON (*See* "Hyalography.")

GLASS, GREEN (*See* "Green Glass.")

GLASS, PHOTOGRAPHS ON

In 1848 Niepce de St. Victor produced photographs upon glass in the form of negatives, but glass as a support for photographs was suggested by Sir John Herschel in 1839. About 1850 Archer produced positives on glass by the collodion process.

Photographic negatives are now almost entirely upon glass or celluloid. Photographic positives on glass are produced in many ways, as described under the headings "Lantern Slides," "Window Transparencies," etc.

GLASS POSITIVES

Photographs on glass, such as lantern slides. The early glass positives were produced by the collodion process, and the deposit forming the image was white and the shadows clear glass, there being a backing of black velvet, cloth, or paint.

GLASS, RUBY (*See* "Ruby Glass.")

GLASS, SILVERED

Photographers and process workers are well advised not to prepare their own mirrors and prisms, but the question of silvering is important. The silvered surface must be thick and durable to withstand the frequent polishing for removal of tarnish. Mirrors should be thoroughly warmed before polishing, and the polishing pad and rouge must be quite dry and warm. The very finest optical rouge should be used, and the pad should be rubbed on a clean glass plate before applying it to the mirror. The pad should be kept in a wide-mouthed glass jar with glass stopper when out of use, so that no gritty dust can reach it. The silvering on the hypoteneuse of prisms should be backed with an electro-deposit of copper and then varnished.

GLASS, SOLUBLE (*See* "Water-glass.")

GLASS, YELLOW (*See* "Yellow Glass.")

GLASSWARE, PHOTOGRAPHING

Photographically, glassware is similar to silver ware, and the instructions for lighting, etc., given under the latter heading apply almost as well to glass vessels. Glass may sometimes be improved by frosting or dewing, as described for silver ware, but in most cases it is advisable to fill the glass vessels with a non-actinic solution, in order to prevent the details and high lights on the far side conflicting with those nearest the camera. A non-actinic solution may consist of a very dilute solution of potassium permanganate, but it must be only slightly tinged, otherwise it will appear as ink. Another plan is to dust the glasses lightly with powdered talc, using this for partly filling up engraving in order to make it show more distinctly upon the negative. The background should be of a dark tint.

In process work, numerous expedients are resorted to for photographing glassware for catalogue illustrations. A piece of ice put inside the vessel will cause moisture to condense on the outside, and so stop reflections. Dabbing the glass over with putty is also effective on smooth surfaces, but does not avail with cut-glass. Coating the glass with a varnish and blackleading with a brush has also been resorted to. Spraying the glass with the aerograph also serves the purpose.

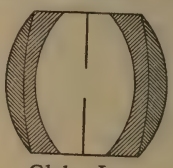
GLAZING PRINTS (*See* "Glossy Surfaces on Prints.")

GLAUBER'S SALT

Another name for sodium sulphate (*which see*). First produced by Johann Rudolph Glauber, a German chemist, about 1661; hence the name.

GLOBE LENS

One of the earliest non-distorting, wide-angle lenses, introduced by Harrison, of New York, in 1862, and highly esteemed until superseded by the wide-angle rectilinear. Its chief defects



Globe Lens

were slowness (full aperture *f*/36) and liability to flare. It was symmetrical in construction, the outer surfaces of the two components being so placed as to form part of a sphere, as shown.

GLOBE POLISH REDUCER (*See* "Baskett's Reducer.")

GLOSSY PAPERS

These are almost always prepared with gelatine. Their gloss may be enhanced in finishing by the procedure given under the heading "Glossy Surfaces on Prints." A glossy surface possesses the advantage of imparting great depth and transparency to the shadows, and of rendering all detail crisply throughout the scale of tones. It also gives greater visual contrast in the print. For this reason, prints with glossy surfaces are very desirable for reproduction purposes, and for many kinds of commercial photography, engineering subjects, architectural details, etc. There are several papers on the market, both for daylight and for artificial light printing, with semi-glossy surfaces.

GLOSSY SURFACES ON PRINTS

For finishing prints with a glossy surface, a paper prepared with a naturally glossy surface should be employed. The most simple and satisfactory method of working is as follows: The prints, after fixing and washing, should be immersed in a formaline bath (formaline ½ oz., water 5 oz.) for two or three minutes, washed

for a quarter of an hour, and then dried. A glass, celluloid, or ferrotype plate is washed and polished with a soft fabric, first rubbing on with a flannel a solution of 20 grs. of beeswax in 1 oz. of turpentine. The print is soaked in water until thoroughly limp, and then a liberal quantity of water is thrown on the polished plate, and the print placed face downwards on the plate, care being taken that there is plenty of water between the two surfaces. The print is next firmly squeegeed into contact, interposing a sheet of rubber cloth between the print and the roller squeegee. When quite dry, the print will leave the plate very easily, and its surface will possess a high gloss. This surface is hard and durable, due to the employment of the formaline bath, but it is well to back the print with a waterproof sheet so as to prevent the mountant from affecting the glaze.

GLUCOSE (Fr., *Glucose ;* Ger., *Glycose*)

Synonym, dextrose, grape sugar. $C_6H_{12}O_6$. Molecular weight, 180. A thick, syrupy, yellowish liquid, obtained by the action of dilute sulphuric acid on starch. It was suggested as a developer or addition to developers for wet plates.

GLUE, FISH (*See* "Fish-glue.")

GLYCERINE (Fr., *Glycérine ;* Ger., *Glyzerin*)

A colourless, odourless, thick liquid of characteristic sweet taste, miscible in all proportions with water and alcohol, and slightly soluble in ether. Glycerine as purchased from a chemist or at an oilshop is good enough for photographic purposes. It has many uses in photography, for example, in developing platinotypes, as a constituent of developers, as an addition to gelatino-chloride and collodio-chloride emulsions, in mountants, and to prevent films curling.

In collotype work, glycerine is used for the "etching" or damping of the plate previous to inking. A suitable solution consists of 3 parts glycerine to 2 parts water.

GLYCEROL (*See* "Glycerine.")

GLYCINE, OR GLYCIN (Fr., *Glycine ;* Ger., *Glycin*)

A developer, known also as paraoxyphenylglycin, having the formula $C_6H_4OH\,NHCH_2COOH$. It appears in the form of glistening grey powder, which, when carelessly kept, turns to a brownish black and loses its developing powers. The powder is insoluble in plain water, but soluble in a solution of sodium sulphite, or on the addition of an alkali. It is a slow-working developer, having a factor of 7, and works after the manner of ferrous oxalate ; it has the advantage of giving good clear negatives with little or no fog, and good density. It is widely used for stand and tank development and for the reproduction of black-and-white subjects ; it may be used in a one-solution or two-solution form.

One-Solution Developer

Hot water	30 oz.	1,000 ccs.
Sodium sulphite	1¼ „	45 g.
Potassium carbonate	2½ „	90 „
Glycin	½ „	18 „

The above is ready for use.

Another one-solution formula gives a stock solution in the form of a cream, and is known as—

Hübl's Stock Glycine Solution

Sodium sulphite	2½ oz.	688 g.

dissolved in—

Hot water	4 „	1,000 ccs.

then add—

Glycine	1 „	275 g.

Heat to boiling point, and add—

Potassium carbonate	5 oz.	1,375 g.

Add the potassium carbonate gradually in small quantities on account of the carbonic-acid gas. When cold, this forms a thin paste ; when required for use, shake and dilute 1 part with 12 parts of water, using more water for soft development and less water for hard development. For stand development, mix with 50 to 55 parts of water.

Two-Solution Developer

A.	Glycine	380 grs.	44 g.
	Potass. carbonate	144 „	16·5 „
	Sodium sulphite	5 oz.	275 „
	Water	20 „	1,000 ccs.
B.	Potass. carbonate	2½ „	137 g.
	Water	20 „	1,000 ccs.

For use, mix equal parts of A, B, and water. Potassium bromide is added in cases of over-exposure.

Messrs. Newton and Bull have recommended glycine as a developer for all isochromatic plates, as follows :—

Glycine	192 grs.	18 g.
Potass. carbonate	2 oz.	88 „
Sod. sulphite (anhydrous)	240 grs.	22 „
Potassium bromide	12 „	1 „
Water to	25 „	1,000 ccs.

Development is controlled by time, using a factor of 6.

In process work, glycine is an excellent developer for collodion emulsion and for process dry plates, but it is expensive compared with hydroquinone, which is more generally used.

GLYCOCINE (Fr., *Glycocine ;* Ger., *Glykokoll*)

The decomposition product of the action of sulphuric acid on gelatine. It was used as a preservative for collodion dry plates. (*See also* "Amido-acetic Acid.")

GLYCOCOLL (*See* "Amido-acetic Acid.")

GLYPHOGRAPHY

An electrotyping process invented by E. Palmer, of London, about 1844. A copper plate is coated with a white composition consisting of white wax and zinc white, and the coating is scratched through with needles so that the lines are formed in deep furrows. The plate is brushed with blacklead, and forms a mould for electrotyping. (*See also* "Wax Process" and "Cerography.")

GODDARD, JOHN FREDERIC

Inventor of the polariscope ; improved the daguerreotype process by discovering (in 1840)

the accelerating properties of bromine, by which, with iodine, he obtained a bromo-iodide of silver on the surface of the silvered plate, thereby reducing the necessary exposure to about one-sixtieth—from twenty minutes to twenty seconds. This invention, in conjunction with Fizeau's gold chloride and "hypo" invigorator, made the daguerreotype a commercial success, as it then became possible to give reasonably short exposures, whereas previously long exposures were needed, and the sitter's face had to be whitened with powder, and placed in full sunlight.

GOETZ'S REDUCER

A reducer for negatives introduced in 1894 by H. Goetz. A strong solution is made by mixing 1 oz. of copper sulphate with 5 oz. of distilled water:—

No. 1—		
Common salt	¼ oz.	28 g.
Copper sulphate solution	½ ,,	55 ,,
Distilled water	10 ,,	1,000 ccs.
No. 2—		
Sodium hyposulphite	96 grs.	22 g.
Distilled water	10 oz.	1,000 ccs.

The carefully washed plate is placed for from twenty to thirty seconds in solution No. 1, then rinsed and transferred to No. 2, in which the reduction takes place, and the process should be well controlled, the action being a rather quick one. The longer the plate has been left in No. 1 the more rapid will be the reduction in No. 2. For slight over-exposure increase the salt and decrease the copper sulphate in No. 1; the contrary holds good in a case of under-exposure. Finally, the negative should be thoroughly washed.

GOLD (Fr., *Or*; Ger., *Gold*)

Au. Molecular weight, 197. It occurs native in grains or nuggets. A heavy yellow or orange-yellow metal, which, as a metal, is not used in photography. Its salts are used for toning prints. Most of its salts are sensitive to light, particularly the chloride, in the presence of organic matter, and therefore all gold solutions should be kept in the dark.

GOLD CHLORIDE (Fr., *Chlorure d'or*; Ger., *Goldchlorid*)

Synonyms, trichloride or perchloride of gold, auric chloride. $AuCl_3$ HCl $4H_2O$. Molecular weight, 412. Solubilities: very soluble in water, alcohol, and ether. It occurs as needle-like yellow crystals obtained by dissolving metallic gold in aqua regia and evaporating the solution. The crystals are very hygroscopic, and should be kept in a stock solution. There is a brown form of gold chloride, $AuCl_3$ HCl xH_2O, which contains less water than the yellow salt and is less hygroscopic. This should contain from 50 to 51 per cent. of metallic gold. Both salts are used in toning. Gold chloride has a great tendency to form double salts with the alkaline chlorides, which are more stable. (*See* "Gold and Potassium Chloride" and "Gold and Sodium Chloride.")

GOLD AND "HYPO" BATH (*See* "Gold Hyposulphite.")

GOLD HYPOSULPHITE (Fr., *Hyposulfite d'or et de sodium, Sel de Gélis et Fordos*; Ger., *Unterschwefligsäure Goldoxydulnatron, Goldsalz*)

Synonyms, sel d'or, hyposulphite of gold and soda. $AuS_2O_3Na_2S_2O_3$ $2H_2O$. Molecular weight, 522. Solubilities, very soluble in water, almost insoluble in alcohol and ether. It occurs in white needles, and is obtained by adding a strong alcoholic solution of gold chloride to an excess of sodium hyposulphite. It was usually prepared in solution by adding a 2 per cent. solution of gold chloride to a 6 per cent. solution of "hypo." It was used for toning or "gilding" the old daguerreotype image, and is sometimes recommended for printing-out papers.

GOLD AND IRIDIUM BATH

The addition of iridium and potassium chlorides to a gold bath has been recommended for toning prints, but as it presents no practical advantages, and merely increases the cost, it has found no general use. The following is used for toning ceramic substitution pictures, and gives a warm, black tone:—

Iridium chloride	34 grs.	3·5 g.
Gold chloride	20 ,,	2 ,,
Lactic acid	22 mins.	2 ccs.
Distilled water to	20 oz.	1,000 ,,

GOLD AND PLATINUM BATH

The addition of chloroplatinite of potassium to the gold sulphocyanide bath was stated to give rich black platinum tones, whereas, as a matter of fact, all that takes place is the more rapid deposition of the gold. A bath similar in composition to that given under the heading "Gold and Iridium Bath," the iridium being replaced by potassium chloroplatinite, is also used in producing ceramic photographs. Platinum baths are sometimes used after a gold toning bath for P.O.P. papers.

GOLD AND POTASSIUM CHLORIDE (Fr., *Chlorure d'or et de potassium*; Ger., *Kaliumgoldchlorid*)

KCl $AuCl_3$ $2H_2O$ or $KAuCl_4$ $2H_2O$. Molecular weight, 414. Solubilities, very soluble in water, alcohol, and ether. Yellowish needles obtained by mixing four parts of gold chloride in concentrated solution with 1·12 parts of potassium chloride, evaporating, and crystallising. It is used for toning.

GOLD RESIDUES (*See* "Residues.")

GOLD AND SODIUM CHLORIDE (Fr., *Chlorure d'or et de sodium*; Ger., *Natrium goldchlorid*)

NaCl $AuCl_3$ $2H_2O$, or $NaAuCl_4$ $2H_2O$. Molecular weight, 398. Solubilities, very soluble in water, alcohol, and ether. Yellowish orange crystals, obtained in the same way as the potassium salt (*see* "Gold and Potassium Chloride"), using 4 parts of gold chloride and 1 part of sodium chloride. Both these salts may be adulterated with free potassium or sodium chloride, which may be detected by dissolving them in absolute alcohol, when any alkaline chloride will be undissolved.

GOLD TONING (Fr., *Virage à l'or*; Ger., *Tonen* (*Schönen*) *mit Goldsalz*)

The purpose of the gold toning bath is to convert the somewhat unpleasant yellowish red colour of the fixed silver image into a more pleasing brown, purple or bluish purple. This has been erroneously described as "gilding," whereas the action is purely chemical, the gold taking the place of the silver of the image, and the silver being converted into chloride in place of the gold. If instead of a plain solution of gold chloride the auric chloride $AuCl_3$ were used, the reaction could be expressed as follows:—

$$AuCl_3 + 3\,Ag = 3\,AgCl + Au$$

From this it will be seen that one atom of gold replaces three atoms of silver, and the fine details in the high lights would disappear and the image lose considerably in vigour. If, on the other hand, the gold is reduced to the aurous chloride AuCl, the reaction would be represented by—

$$AuCl + Ag = AgCl + Au$$

and one atom of gold would replace one atom of silver. It has been stated that an intermediate aurous chloride, $AuCl_2$, is formed, but it is such an unstable salt that its existence is doubtful. To convert any toning bath into the proper toning condition—that is, when the gold is reduced to the aurous state—it is "ripened" either by allowing it to stand or by the use of hot water to dissolve the salts, which should make the bath either neutral or distinctly alkaline. In the case of the sulphocyanide bath, a double salt of sulphocyanide of ammonium or potassium and gold is formed; this may also be in the auric or aurous state, and a similar chemical action takes place. Of recent years a more reasonable method of using the gold bath has been generally adopted, this allowing a definite quantity of gold to a definite area of print, instead of using one bath for a number of prints in succession and then adding fresh gold. It is important to wash prints well before toning, so as to free them from the excess of silver nitrate, which would decompose the gold chloride and prevent its deposition on the print. When a toning bath has been used, all the gold is not exhausted; but some which has passed into a stable aurate will not deposit. Obviously this may be collected for the sake of the residues, or the old bath may be used instead of water to make a new bath, the former plan being preferable. (*See also* "Residues.")

GOLD TRICHLORIDE OR PERCHLORIDE

(*See* "Gold Chloride.")

GOLD AND URANIUM BATH

A mixture which has been frequently suggested for obtaining warm black tones on matt surface print-out gelatine or collodion papers:—

Gold chloride	2½ grs.	·25 g.
Uranium nitrate	2½ ,,	·25 ,,
Sodium chloride	10 ,,	1 ,,
Sodium acetate	10 ,,	1 ,,
Distilled water to	20 oz.	1,000 ccs.

Dissolve the gold and uranium in a little water, neutralise with sodium bicarbonate, and add to a hot solution of the other salts. The bath is ready for use when colourless and cold.

GOUPIL PROCESS

A method of making facsimiles of water-colour drawings. A photogravure plate is carefully inked by hand with small dabbers or tampons, and in the more delicate parts with brushes, using differently coloured inks according to the character of the portions of the plate to be inked. When the inking is complete the coloured print is obtained at one impression. The plate is then cleaned and inked again for the next picture. This method of printing is very slow and costly, as skilled artists have to be employed for colouring the plates. The results, however, are very fine, and in some cases hardly distinguishable from the original water-colour drawing. The process is still practised.

GOUPIL GRAVURE

A photogravure process suggested to Goupil and Co., of Paris, by W. B. Woodbury, about 1870, and largely worked afterwards by that firm. A gelatine relief was made in the same manner as for the Woodburytype process, except that a fine gritty powder was added to the gelatine to give the necessary grain. From this relief a mould was taken and an electrotype shell deposited on it.

GRADATION

That variation of tones in a print by which are suggested differences in colour and in light and shade. A print has a long scale of gradation when there are many intermediate tones between deepest shadow and highest light. (*See* "Key.")

GRAIN IN COPYING

Copies of photographs frequently have a "grainy" effect, due to the dry plate reproducing the grain of the paper on which the original photograph was printed. To reduce the effect as much as possible, the original should be placed for copying in a good diffused front light; it is the character of the lighting that is generally to blame when the grain is reproduced prominently, as the stronger the light from one point, usually one side, the more pronounced is the grain. A method of obviating grain is to smear the face of the original with glycerine and squeegee it face downwards on plain glass, the copy being then made through the glass.

In process work, the suppression of grain is more easily attained, now that the use of the electric arc has become common, than it was when daylight copying was in vogue. By the use of two arc lamps, one on each side of the copy, the illumination can generally be adjusted to overcome the effect of the grain. Also the originals may be photographed under plate glass.

GRAIN IN NEGATIVES

In the early days of rapid plates a grain was perceptible in the negative, it being coarser as the speed of the plate increased; but the defect has now almost vanished, although it may still be produced under certain conditions. "Grainy" negatives are more frequent in hot weather than

in cold; in the summer, and particularly when development is forced and the plate happens to be under-exposed, excessive coarseness of grain may often be seen. The temperature of the atmosphere during the drying of the negative affects the grain, and the more quickly a negative is dried the coarser will be the grain; therefore, when a negative is to be used for printing upon glossy paper, or lantern slides are to be made from it, the cooler the atmosphere employed for drying the better. One theory (there are several) is that when negatives dry slowly on a hot day, the gelatine becomes partly decomposed, allowing the particles of the silver bromide to come together; these particles have an affinity for each other, and are enabled to come together when the gelatine which keeps them apart has been to some extent destroyed. Thus the particles form coarse particles, and impart to the negative a "grainy" or woolly appearance. Excess of alkali also increases grain; therefore, in order to produce a negative as grainless as possible, let the exposure be full, use a normal developer at no higher temperature than 65° F. (18° C.), and dry as quickly as possible in a cool, clean current of air.

In process work, it is a disadvantage to use a plate that gives too granular an image. Hence, process dry plates are relatively slow in order to secure a fine-grained emulsion. In collodion emulsion work also, the grain must be kept fine.

GRAINED NEGATIVE

A term often employed to denote a half-tone process negative, or a negative made through a ruled screen for breaking up the image into a fine grain.

GRAINS PER OUNCE

See under the heading "Solutions, Making up," where the number of grains per ounce of solutions of the usual "percentages" will be found.

GRAM, OR GRAMME

A metric weight, equivalent to 15·432 grains avoirdupois, apothecaries', or troy; written g. or gm. in formulæ. (*See also* "Weights and Measures.")

GRANULATION, OR GRANULARITY (Fr., *Granulation;* Gr. *Granulieren*)

A term usually applied to an image of which the grain is coarse and distinctly visible to the naked eye. It may be due to the emulsion or to the action of the developer. It is also occasionally used for images broken up into a grain photo-mechanically.

GRANULOTYPE

A term applied to a half-tone etching on grained zinc, the image being formed by means of the bitumen process, printed under a tone negative.

GRAPHOSCOPE

An instrument containing a double convex lens large enough to permit both eyes at the same time to look through it at a single photograph, in this way obtaining, it is said, an illusion of relief, but not that solidity observable in a stereoscope. The suggestion of relief may be due to the non-achromatic lens causing overlapping of the different rays.

GRAPHOTYPE

A process suggested by A. H. Wall, in which a block of compressed chalk was drawn on with a specially prepared ink, which hardened the chalk wherever the lines were made, whilst the clear parts could be brushed away until a high relief printing block was obtained. The chalk no doubt contained size, and the ink some hardening substance, such as chrome alum, tannin, or formaline. In another process of this kind the block of chalk is treated with water-glass, to harden it after brushing it into relief.

GRATING, DIFFRACTION (*See* "Diffraction Grating.")

GRATING, PRISM

A diffraction grating on the hypotenuse of a prism of 60°, used for direct-vision diffraction spectroscopes. An ingenious method of making these gratings was devised by Thomas Thorp, of Manchester. He flows a plane metallic diffraction grating with celluloid, which when dry is stripped off as a film and cemented to the prism; it gives an image hardly inferior to that produced by the original grating.

GRATING, SCREEN

A term sometimes applied to the ruled screen used for half-tone process work.

GREEN FOG (*See* "Fog, Colour, etc.")

GREEN GLASS

Printing through green glass increases the contrasts on P.O.P. The use of coloured glasses was suggested by Lemann in 1861, since when it has been repeatedly adopted for obtaining rich prints from thin and flat negatives. About 1890 the use of greenish yellow glass was advocated for obtaining, in conjunction with matt papers and the uranium toning bath, not only vigorous prints, but also black tones resembling platinotype. Glossy P.O.P. also prints very much brighter and better under green glass, and the method is of great advantage when valuable negatives of a flat, thin, or ghostly character are used and intensification is not allowable. A green glass cuts out the violet and deep blue rays of light, allowing the bright blue, green, and yellow rays to travel through the negative and act upon the sensitive paper, with the result that the organic salts of silver are acted upon more than the chloride. The organic salts have a shorter scale of gradation than the chloride has, hence the prints have stronger contrasts and the shadows are richer than would otherwise be the case. The most suitable shade of glass for the purpose is that known as "signal green" or "single flashed chromium green." With the green glass, which is placed over the negative, printing is considerably prolonged. The method answers only with print-out silver papers. Green glass has also been advocated in place of ordinary glass for dry plate making; it has several advantages, one being that it prevents halation.

GREEN TONES

Green tones are generally difficult to obtain and not of great permanency except by the carbon process. Carbon tissue in many shades of green may be purchased, and greens by the process are easy to obtain, of even quality and quite permanent.

P.O.P.—The green tones obtainable on P.O.P. are uncertain as to exact tone, and they are not permanent. The best method is to tone as black as possible in the usual way, and then to stain the print with an aniline dye. Another method is to print very faintly, and then, without washing, immerse the print in a 10 per cent. solution of potassium bromide for three minutes. The faint image is then developed with a metol-hydroquinone developer as used for bromide paper, then washed and fixed in the usual way, without toning.

Bromide Paper.—The following is a typical method, which not only gives a good green, but intensifies considerably at the same time. Make 10 per cent. solutions (48 grs. in 1 oz. of water) of (1) uranium nitrate, (2) ammonio-citrate of iron, (3) potassium ferricyanide, (4) nitric acid. For use mix together No. 1 12 drops, No. 2 12 drops, No. 3 24 drops, No. 4 24 drops, and add water to make 1 oz. Immerse print until of the desired colour, wash, and dry. A much brighter green may be obtained by mixing together ½ oz. of No. 2, ½ oz. of No. 3, and 5 oz. of a 10 per cent. solution of acetic acid. Tone, rinse, and transfer to a 10 per cent. solution of chromic acid; rinse, and immerse in a 5 per cent. solution of alum; then wash and dry.

GREENHOUSE AS STUDIO

(*See* "Studio Design and Construction.")

GREENLAW'S PROCESS

A modification of the calotype process for obtaining paper negatives. Thin paper was immersed for about an hour in a solution of potassium iodide and potassium bromide, containing sufficient iodine to give it a dark claret colour. It was then dried, sensitised as required in an acidified silver nitrate bath, rinsed, and again dried. After exposure in the camera, the paper was developed with gallo-nitrate of silver, rinsed well, fixed with "hypo," and washed.

GROUND GLASS

Besides its use for the focusing screen (*which see*), it is also employed to diffuse the light in dark-room lamps, in enlarging apparatus, and in printing. Sometimes it is employed in glazing the studio, when direct sunshine has to be excluded or an objectionable view blocked out. A piece of ground glass may be placed behind the negative in the retouching desk, to give a softer and more uniform light. Ground glass is also used to give a matt surface to P.O.P. prints.

GROUND GLASS, COPYING THROUGH

In making half-tone process blocks from a half-tone print, very finely ground glass may be used to prevent the crossing of the two dot images from forming an objectionable pattern. The plain side of the glass is placed in contact with the print, and the ground side is rubbed with a trace of glycerine.

GROUND GLASS PLATES (Fr., *Plaques à verre dépoli*; Ger., *Mattglasplatten*)

Plates having the emulsion coated on finely-ground glass instead of plain glass, or on a specially prepared matt substratum. The latter idea was originated by E. J. Wall. Softer prints are obtained from the resulting negatives, while the matt surface offers great facilities for working on with pencil. Such plates are especially suitable for stereoscopic and other transparencies. Plates coated with a matt emulsion beneath the sensitive emulsion are obtainable commercially under the name of "Matt-ground," or "M.G."

In process work, thick plate glass ground on one side with emery powder is used as the support for the collotype printing film.

GROUP ARRANGEMENT

There is some truth underlying the saying that "two are a group, three a crowd." The difficulty of securing a perfect rendering of a single figure is enormously added to by every further addition. In fact, when many figures are to be included at the same time it is hardly possible to secure anything more than a number of mere portraits. When the group is a small one it is often possible to secure a natural arrangement in which each member has some common point of interest or occupation. In such a case, however elaborately the sitters may be "arranged," the result should appear natural and fortuitous, as though it had merely been taken at a happy moment. The figures must not be placed with any appearance of balance or symmetry having been deliberately aimed at, but at the same time they must not seem independent and isolated.

In the case of larger numbers, such a homogeneous composition is practically out of the question. The worst arrangement that can be made is, unfortunately, the most common one. This is placing the figures in one or more straight lines right across the picture. A narrow band of small figures with a wide expanse above and below is never satisfactory. It is better, whenever possible, to take advantage of a sloping bank or a flight of steps, so as to increase the height of the group on the plate. Such a group must not appear ill-balanced or lop-sided. Another common fault to be avoided is the use of a short-focus lens, which exaggerates the difference in apparent size between the nearer and more distant figures. A long-focus lens and a more distant standpoint give a more natural effect.

A football or cricket team, a wedding group, a family party, and so on, admit only of a more or less formal treatment, the desideratum being a collection of good portraits. This does not apply to renderings of groups for what may be called pictorial purposes, such as fishermen on the beach or women in a market place. In such cases any attempt at deliberate arrangement is often impossible, and oftener inadvisable. The only satisfactory method is to watch carefully the ever-varying arrangement of the figures composing the group and to seize the most promising opportunities that offer. Appropriate and characteristic poses should be watched for, with careful regard all the time to the relative positions of the members of the group. The

figures will from time to time naturally fall into satisfactory arrangements, and these moments must be waited for and taken instant advantage of. As has been said, the difficulty of obtaining a perfect arrangement increases with the number of figures included, but it is seldom possible to make this arrangement deliberately without introducing a suggestion of unnatural posing and stiffness. In a satisfactory group arrangement it must be remembered that all the figures must not claim equal attention; some should be prominent and others duly subordinate.

GRÜN LENS

A fluid lens (*which see*), said to be filled with cedar oil; it works at a large aperture and has been used for theatrical photography.

GUAIACOL (Fr., *Gaïacol;* Ger., *Guajakol*)

Synonym, methylcatechol. A faintly yellowish, limpid liquid obtained from beechwood creosote by fractional distillation. It was supposed to be a developer, but more careful purification proved that it was an impurity that acted, and not the guaiacol itself.

GUAIACUM RESIN

The resin obtained from guaiacum or lignum vitæ is sensitive to light, and North has patented a process in which guaretinic acid, obtained from the above, was the light-sensitive compound with or without the admixture of dyes. It has found no practical application.

GUM CUTCH (*See* "Catechu.")

GUM ELASTIC (*See* "Indiarubber.")

GUM GALLIC PROCESS

A dry collodion process used by Hardwick in 1860, and improved by Manners Gordon in 1868. The plate is edged with albumen and coated with collodion, to each ounce of which is added 1 gr. of cadmium bromide; next it is sensitised in a silver bath in the usual way. After that the following gum gallic solution is used as a preservative:—

A.	Gum arabic . .	20 grs.	1·3 g.
	Sugar candy . .	5 ,,	·32 ,,
	Water . . .	6 drms.	21 ccs.
B.	Gallic acid . .	3 grs.	·2 g.
	Water . . .	2 drms.	7 ccs.

A and B are mixed together and poured over the plate, this being next drained and allowed to take its own time to dry. The exposure necessary is from four to twenty times that for a wet plate. The developer specially recommended is:—

A.	Gelatine . . .	64 grs.	4 g.
	Glacial acetic acid .	2 oz.	57 ccs.
	Water . . .	14 ,,	400 ,,
B.	Iron protosulphate .	30 grs.	2 g.
	Water . . .	1 oz.	28 ccs.

One part of A is mixed with three parts of B, preferably one or two days before use. Before developing, immerse the plate in lukewarm water for a short time in order to soften the gum. Additional density is generally desirable and is obtained with a pyro-silver intensifier. The plate is finally fixed in "hypo," and washed.

GUM OZOTYPE (*See* "Ozotype Process, Gum.")

GUM PLASTIC (*See* "Guttapercha.")

GUM SILVER PROCESS

A "plain paper" printing process by means of which print-out pictures may be obtained on almost any kind of paper, ordinary writing-paper answering quite well. Three solutions are required for sensitising:—

No. 1.	Powdered gum arabic	1¾ oz.	54 g.
	Water . .	3½ ,,	100 ccs.
No. 2.	Solution No. 1 .	84 mins.	5 ,,
	Glacial acetic acid .	50 ,,	3 ,,
No. 3.	Silver nitrate . .	15 grs.	1 g.
	Water, distilled .	50 mins.	3 ccs.

In preparing solutions Nos. 1 and 3, the gum and the silver must be pulverised. Add No. 3 to No. 2, mix well together, and apply it with a fairly stiff brush to the paper, which is then dried in the dark; a brush bound in metal should not be used, but if none other is available see that the metal binding does not touch the solution or the paper. The paper prints well as soon as dry, but better still, and the tones are richer, if used about thirty hours after preparing. The paper is printed in the same way as ordinary P.O.P., and good red tones may be obtained by printing to a suitable depth and fixing in a weak "hypo" solution (48 grs. in 5 oz. of water). Colder and purplish tones may be obtained by toning in a gold or platinum bath, or even in a combined bath. The finished tone depends largely upon the quality of the negative.

GUMS AND RESINS

The photographer uses gums and resins chiefly in the form of varnishes.

Amber, a fossil resin, ranging in colour from colourless to reddish-brown, is slightly soluble in ether and turpentine; treated in the same way as copal in varnish making, it dissolves in turpentine, petroleum and benzine.

Anime, or Zanzibar copal, is of two kinds, fossil and "recent," the former being superior; of pale yellow or yellowish-brown colour and having a rough surface-called "goose skin." It is very hard, and, for varnish making, needs to be treated in the same way as copal; but it is slightly soluble in ether, benzine, chloroform, cold turpentine, etc.

Copal, a fossil gum, of pale yellow colour, hard and transparent; soluble slightly in cold turpentine and fully soluble in turpentine when fused or "run" in a copper pan over a fire, a process that must be left to the varnish manufacturer.

Dammar is known in several forms, ranging in colour from colourless or pale yellow to dark brown and black. It is soluble in oil, ether and benzene.

Dragon's blood is of various kinds, the chief being of blackish-brown colour and being in sticks about 1 in. thick; soluble in alcohol, benzene, chloroform, carbon bisulphide, etc.

Elemi is of many kinds and of a white or greyish appearance; it is soluble in alcohol.

Guaiacum is described under its own heading.

Gum arabic, small rounded nodules of yellow

or brownish-yellow colour, is soluble in water but insoluble in alcohol.

Gum benzoin, or gum benjamin, occurring in large blocks of grey or brown colour, with almond-shaped particles of a cream colour, is easily pulverised between the fingers, and has a fragrant odour; soluble in alcohol and slightly so in ether and turpentine.

Gum sandarach, a soft, bright gum, resembles tears or pears in shape, and is semi-transparent; soluble in alcohol, and slightly so in benzine, petroleum, and turpentine.

Gum tragacanth, or gum dragon, moss-like pieces of whitish colour, is opaque, hard, and tough; it forms a thick emulsion with water.

Lac is a brown gum, known in many forms—including shellac (shell lac), seed lac, lump lac, stick lac, etc.—which are prepared from a resinous incrustation on the twigs of certain trees. It is soluble in alcohol and ether, and partially so in turpentine. White lac or bleached lac is used in preparing colourless varnish.

Mastic is in the form of tears of a pale yellow colour, brittle, and easily melted; soluble in alcohol and turpentine. It is used in preparing mastic varnish.

Resin, an amber-coloured or brown oxidation product of turpentine, is brittle, easily melted, of lustrous appearance in a thin coat, and is soluble in alcohol, turpentine, etc.

GUM-BICHROMATE PROCESS

Familiarly known as "bi-gum," this process depends on principles first laid down by Poitevin in 1855. Briefly, it consists in coating paper with a mixture of gum and pigment sensitised with potassium bichromate solution. This paper is printed under a negative, the bichromated colloid becoming more or less insoluble in proportion to the light action. In this way a print may be obtained with a single coating, but it is usual to re-coat the print thus made and again print and develop. This may be repeated almost indefinitely, either for the purpose of reinforcing certain parts of the image, or for producing prints in more than one colour. The paper used must be well sized, in order that the pigment may lie on the surface and not sink into the substance of the paper so as to stain and degrade the high lights. If the paper is not already sufficiently sized a formula suggested by Mummery is 3 to 5 per cent. of gelatine in water with 5 drops of formaline to the ounce. This is brushed evenly over the paper.

The experienced gum worker frequently evolves his own formula for coating the paper. It is best to arrive at this experimentally by proceeding in some such manner as the following: 2 oz. of good clean gum arabic in tears is enclosed in a muslin bag and suspended in 6 oz. of cold water for about two days. This provides the gum solution. Next, a saturated solution of ammonium or potassium bichromate is made. Lastly, the pigment may take the convenient form of moist water colours in tubes. A mixture may then be made of 10 parts gum solution, 5 parts bichromate solution, and a quantity of the pigment to be judged always by the length of the "worm" of colour squeezed from the tube. Less bichromate will make the paper less sensitive. The ingredients of the mixture must be thoroughly incorporated by rubbing down on a slab or sheet of glass with a palette-knife.

The sized paper is coated with this mixture by means of a camel-hair mop, a hog-hair softener being passed over the surface afterwards in both directions to make it smooth and even. All this must be done quickly before the coating hardens. After about half an hour the paper should be thoroughly dried by heat and placed in a calcium tube if it is to be kept, although it is best to use it as fresh as possible. It must be borne in mind that the paper is very sensitive to light.

Duration of printing depends to some extent on the composition of the coating. As the image is not visible an actinometer must be used as in carbon printing, or a piece of P.O.P. exposed simultaneously under a negative similar in printing speed to the one in use. As a rule, the bichromate paper will be sufficiently exposed when the P.O.P. image looks of the right density.

The gum print is now placed face downwards in a dish of cold water. The pigmented gum will soon begin to leave the paper slowly. It is here that the worker begins to exercise that control over the development that constitutes the chief value of the process. He may employ cold or tepid water by laving, spraying, sponging, or brushing. By such means he retains only such of the pigmented gum as he requires for the rendering of his idea of the subject.

If further printing is contemplated the print is dried and the processes of coating, printing, and developing repeated as before. Here comes in the difficulty of obtaining perfect registration of the second or subsequent images, and some device is necessary for securing that the print shall be replaced exactly in its original position on the negative. Even then there is the expansion and contraction of the paper to be reckoned with.

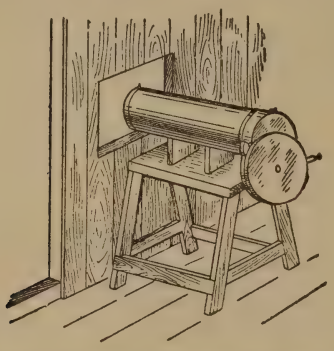
When the final development is complete the print is soaked in a 5 per cent. solution of potash alum to remove the bichromate stain, and then rinsed in water.

The use of various papers, the number of pigments available, the different effects resulting from modifications in coating and development, the power of multiple printings in one or more colours—all these afford opportunity for considerable exercise of control over the final result. But the very existence of these variable elements precludes the possibility, even if it were desirable, of laying down any hard and fast rules for working the process. The individual worker must gradually formulate his methods by careful experiment and observation, in which case he will ultimately find the process most plastic, interesting, and valuable. (*See also* "Arabin Gum-bichromate Process.")

GUN AND REVOLVER CAMERAS (Fr., *Fusil photographique, Révolver photographique, Chambre révolver;* Ger., *Feuergewehr-kamera, Revolver-kamera*)

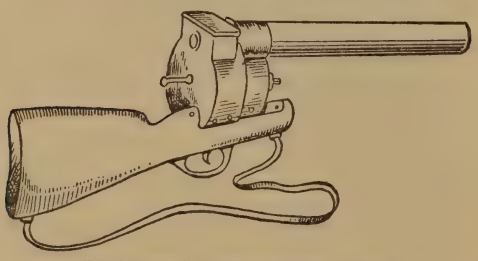
The photographic revolver—the first instance of an efficient automatic apparatus for chronophotography—was designed in 1874 by P. J. C. Janssen, the astronomer, to obtain a record of the transit of Venus. The observation was made in Japan, the instrument being placed

under cover, as shown at A, and directed on a heliostat, to keep the sun's image stationary. Forty-eight pictures were taken in succession on a circular plate, which was caused to make one revolution in seventy-two seconds, and stopped at the correct intervals by a Maltese



A. The Janssen Photographic Revolver

cross movement. The exposures were given by a rotating disc with twelve openings, moving at a different speed to the plate. A fixed partition, having a single aperture, was placed between the plate and the shutter disc, so that a different portion of the plate, then at rest, was exposed each time an opening in the shutter passed the fixed aperture. The operation was repeated four times to obtain a satisfactory record. On this model Marey founded later his photographic gun B. A long-focus lens was placed at the end of the barrel, thus rendering it feasible to photograph small objects from a distance, and the tube was arranged to telescope for focusing. The clockwork mechanism is illustrated at C, the back cover being removed. On pressing the trigger E, a circular shutter with one aperture commenced revolving. Be-



B. Marey's Photographic Gun

hind this rotated a disc F with twelve openings (only half is here shown), the sensitive plate revolving at the back of the disc by friction. The perforated disc and plate were moved intermittently by a pawl G, on an arm worked by an eccentric, and each time one of the openings in the disc F came to rest in line with the lens the aperture in the shutter passed in front of it, making an exposure. During its movement the plate was protected from light by the opaque part of the shutter. (*See also* "Chrono-photography.")

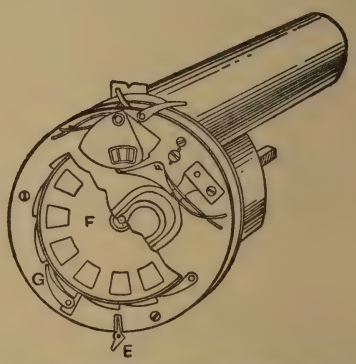
Detective cameras and naturalists' cameras of various kinds have been proposed from time to time under one or other of the names given at the head of this article.

GUN-COTTON

A nitro-cellulose, the hexanitrate, which is extremely explosive. The term is sometimes wrongly applied to pyroxyline.

GUTTAPERCHA (Fr. and Ger., *Guttapercha*)

A natural product having many similarities to indiarubber, but capable of being made plastic and malleable by heat, and retaining, when cold, any shape given it while hot. Whereas guttapercha is plastic, indiarubber is elastic; and whereas indiarubber easily combines with sulphur, guttapercha will neither combine nor intimately mix with that substance. Guttapercha is the coagulated juice of the *Isonandra*



C. Mechanism of Marey's Gun

gutta, which grows in the tropics, particularly in the Malay district. Its principal uses in photography are as a material for dishes and bottles to contain hydrofluoric acid, and as a mountant. For the latter purpose, a piece of very thin sheet guttapercha, the size of the print, is placed on the mount, next the print is laid over it, and then comes a sheet of blotting-paper, over which a hot iron is passed slowly and firmly. The heat softens the guttapercha, which then adheres to both mount and print. An objection to the method is the liability of the guttapercha to perish.

A cement, made by dissolving 2 parts of shredded guttapercha and 2 parts of powdered Syrian asphalt in a mixture of 10 parts of oil of turpentine and 5 parts of carbon bisulphide, makes an excellent cement for leather and other materials.

Guttapercha has been used for coating paper in order to transfer collodion films. It has also been used for stripping negatives, instead of using rubber solution. By the addition of guttapercha to collodion the latter is rendered not only tougher, but more sensitive.

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